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JOURNEYS IN THE NORTHERN ANDES

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THE Cordillera de Merida is a north-eastern branch of the main chain of the Andes, from which it diverges in the neighbourhood of Cúcuta, near the Venezuelan–Colombian border. It is some 250 miles long and 40 miles wide, and reaches its greatest altitude in the Pico Bolívar, 5007 metres, the highest summit in Venezuela and the culminating point of the snow massif near the centre of the range. To the north-east the range gradually peters out in the plains of Barquisimeto, and is unconnected with the coastal sierra in the region of Caracas. This cordillera, a mere outrider of the mighty Andes, possesses many distinguishing features, including a highly specialized flora. Of particular interest is the genus *Espeletia* (Compositae) the Andean counterpart of the African tree-senecios. These remarkable plants are peculiar to the *páramos* of the northern Andes, and are found in Venezuela, Colombia, and Ecuador. There are thirty known species of the genus, eighteen of which are found in Venezuela alone. The growth and distribution of the genus present many unusual botanical features. The term *paramo* needs some explanation: it is a local term, and, like most local terms, rather vague in its scope; at altitudes between 3000 metres and 4000 metres lie regions of open moorland of alpine character with a scanty vegetation of coarse grass, mosses, heaths, ferns, and shrubs. The term paramo sometimes includes the lower peaks, but it does not include the snow ranges. The paramos are not continuous, but frequently isolated one from another by deep valleys filled with tropical evergreen forest, thus leaving alpine islands on which some interesting differentiation of species has occurred.

Early in 1938, with the assistance of the authorities at the Royal Botanic Gardens, Kew, I made preparations for a botanical expedition to the Cordillera de Merida, accompanied by my wife, with the main object of making as representative a collection as possible of the paramo flora. There had been few previous collections from the paramos and the Kew Herbarium was

scantily represented in this section. Drs. Pittier and Jahn had made considerable collections in recent years, but little of their material had reached Kew. The earlier collections of Funck, Moritz,[1] and Schlim had gone mostly either to American or to continental herbaria. A number of paramos were still botanically unexplored, and there was a good prospect of obtaining some new species.

We planned to spend some six or seven months in the Cordillera, and, in order to include as many paramos as possible, we decided to make our base at Merida, making excursions from there by pack-mule and camping at the higher levels for three or four weeks at a time. On reading the accounts of previous collectors it became clear that the constant damp and lack of fuel were going to be our main difficulties, and so it proved. We had intended to continue collecting through the paramos of Colombia and Ecuador, but this plan was later changed to include the Sierra Nevada de Santa Marta, in the extreme north of Colombia. The expedition was curtailed by the outbreak of war after fifteen months in the field.

The main features of the Cordillera de Merida had already been mapped, although some detail still remains to be filled in, and we did not plan to include surveying in our operations until the latter part of the journey.

We arrived at La Guaira on 24 July 1938, and spent a few days in Caracas. Every assistance was kindly afforded us by the British Minister and by officials of the Shell Oil Company. We had been well advised to obtain the bulk of our equipment in England, as prices of all imported goods in Venezuela are extremely high, owing to heavy tariffs. Some local foodstuffs, such as bananas, beans, and coffee, are almost the only articles that can be bought cheaply. Camp servants for an extended mountain expedition in Venezuela are difficult to find. Muleteers are available for short journeys, but, on the whole, the natives are apathetic and unreliable, and definitely non-cooperative when it comes to camping out for more than a few days. We were warned not to rely on finding an Andino cook: "You will get nothing but rice and beans," said one authority; and it is useless to take natives from the steaming coast up to the mountains. In the end we engaged a Chinese cook who had previously worked in the oil camps. He proved disastrously inefficient.

A motor-road, opened in the '20's, leads from Caracas via Barquisimeto up to Merida in the heart of the Andes, 500 miles inland, and on to Bogotá in Colombia. It is for the most part very rough and often suffers severely from floods and landslides, but in spite of its short-comings it has effectively opened up communication with the mountain provinces, which until recently could only be reached by mule-tracks. Our heavy baggage was sent on by lorry to Merida, while we travelled by the weekly bus from Caracas. That journey was a tropical ordeal. Twelve passengers, with miscellaneous baggage, were tightly wedged into a box-body Ford, forming a suffering huddle of humanity for two and a half days. The heat was intense. Refreshments available *en route* consisted mainly of maize bread, black beans, and rather hostile-looking meat, the peak of ingenuity being reached by a dubious concoction of tapioca and tomatoes. The first day's journey led over rolling green hills, with plantations of maize, sugar-cane, and bananas. Turning off the metalled road which

[1] The herbarium of Moritz is at the British Museum (Natural History).—*Ed. G.J.*

The Northern Andes

The Cordillera de Merida

Camp in the valley of the Rio Albaregas, Cordillera de Merida

"Espeletia spicata" with "Culcitium rex" in the background, Paramo de Campanerio

connects Caracas with Puerto Cabello, our route ran for several hours through dense forest with a heavy tangle of creepers and lianas. Late at night we reached Barquisimeto. The following day we passed through arid cactus desert under a burning sun, the Carora plains, and towards evening drove up the valley of the Rio Motatán, cold with mist, to the high Andes. As darkness fell we crossed the pass of Mucuchies, at 4200 metres, and had our first glimpse of the paramos, dotted with the silvery rosettes and yellow flower-heads of *Espeletiae*.

On August 5 we reached Merida, a small Spanish-type town situated in the Chama valley at 1641 metres, on an extensive *mesa* or plateau. These mesas are noticeable features of the Chama valley and are relics of a glacial period. Their flat tops, often a mile or two in length, form natural sites for towns and villages in the otherwise steeply sloping valley. The district of Merida is extremely fertile, with intensive cultivation of coffee, bananas, sugar, and maize. The coffee is of excellent quality and forms the chief item of export. Above the cultivation thick forest commences at about 2000 metres, rising abruptly to the paramo regions. The snowy crest-line of the Sierra Nevada dominates the town to the south-east, culminating in the Pico Bolívar. The permanent snow-line has been observed to be receding rapidly in recent years and now lies at about 4250 metres. The climate of Merida is sub-tropical, with an intermittent rainy season from March to November, which reaches its height in August and September. Some inhabitants claimed there was an intervening dry season in July and August, but this was not borne out by our experience. However 1938 was an exceptional year, and the heaviest rains, with consequent floods, occurred actually in December, nominally the dry season. The driest months of the year are undoubtedly January and February.

We made our base in a small German-owned hotel, and set about obtaining mules through the good offices of Señor Avelino Briceño. Five pack-mules and two riding mules were purchased after some strenuous bargaining. The price of mules in these regions is between £15 and £20, but they can be bought more cheaply near the border of Colombia, whence they are imported. Scarcely any are bred in Venezuela. Hiring mules is advisable only for short trips of a few days. For an extended tour the expense would be excessive, whereas a string of mules can always be re-sold at the end of a trip with only slight loss.

As the rains were particularly heavy in 1938 we decided to wait till later in the year before making a tour to the Sierra Nevada, and meanwhile to devote our efforts to the Sierra del Norte, which bounds the Chama valley on the north-west. The first tour of three weeks was made to the Paramo del Tambor, which had not been visited by previous collectors. It can be reached in three days from Merida, but we planned to make two camps on the way up in order to collect specimens from the lower levels.

The starting-point of the mule track was Egido, a small town 8 miles down the Chama valley lying in a pocket of rich soil, which is the centre of the local sugar industry. The sugar, known as *panela*, is unrefined and made into brownish-yellow bricks. It forms a staple part of the diet of both peasants and mules; our muleteer impressed on us that we must take a load of it up to the paramos, the mules' normal ration being half a brick every other day. A large

sack of maize was also taken, the paramo grass being in most parts unsuitable for grazing.

Venezuela is the home of uncertain travel; a journey, by whatever means, is invariably accompanied by delay, confusion, and recrimination. The start of our small expedition was no exception. Three full hours were spent in loading. Serviceable pack-saddles are unknown in these parts: a mattress of sacking stuffed with straw is strapped to the mule and the rest is accomplished with yards of rope and much faith.

For the first 3 miles the route followed an open valley with cacti and xerophytic scrub. This dry belt is a striking feature of the lower Chama valley; the region appears to have been de-forested and considerable erosion has taken place; it is in marked contrast to the thickly forested upper slopes which verge on the paramos. Passing through the village of La Mesa we camped at Bocono, at 1800 metres, for three days. A common under-shrub, of nearly prostrate growth, with small mauve flowers, was *Centrosema virginianum*. Other shrubs found were *Cassia indecora*, *Aeschynomene fasciculata*, and *Stylosanthes guianensis*. A noticeable tree, not yet fully in bloom, was *Erythrina Poeppigiana*, known locally as the "Ceibo." Towards the end of the year it bears a brilliant mass of orange-coloured flowers. These foothills below the paramos are rich in colour: a country of abrupt green hills, with brown-tiled farmhouses standing among plantations of sugar-cane and maize, alive with brilliantly-coloured butterflies, dragon-flies, humming-birds (*colibri*), and parakeets. It is a rather overpowering scene of tropical luxuriance, with occasional glimpses of the snows on the far side of the Chama valley. There are said to be snakes in this foothill region, but they are comparatively rare. The worst pests are flies, sand-flies, and ticks, which abound in the long grass.

On August 15 we moved camp up to La Playa, at 2100 metres, an area of open park-like country above the village of Jaji. Plants collected here included *Monochaetum Bonplandii*, a low shrub with small magenta flowers, and *Lupinus meridanus*, the common blue lupin of these parts.

On August 20 we made the final climb to the Paramo del Tambor. At first the going was easy, but when we entered the hill jungle our difficulties began. The steep path was a morass of mud and often overgrown by bamboos and blocked by falling timber. The mules made heavy weather of it. Loads frequently came adrift, and much time was spent in readjusting them and in clearing the path. In three hours we had only climbed 300 metres. At length we emerged on to the crest of the Sierra del Norte among the strange, rather freakish vegetation of the lower paramos: large tussocks of coarse grass, grey-green bush, and low trees with broad leathery leaves draped in hanging moss. There was no sign of animal or bird life. The mist hung in wreathing folds.

I had thought the remainder of the route along the crest of the ridge would prove easy going, but we struck an unexpected difficulty: parts of the trail had been worn down into deep narrow trenches, and in these the loaded mules were frequently stuck fast. Two exhausting hours were spent in extricating the mules and carrying the bulk of the loads by hand. In the late evening we made camp at 3000 metres on the northern flank of the Paramo de

Pico Humboldt from a pass above the Paramo de Molina, "Espeletia Moritziana" in foreground

Laguna Negra and south-west arête of La Concha, Cordillera de Merida

"Espeletia Moritziana" in valley near Laguna Negra, Cordillera de Merida

Small church, Sierra Nevada de Santa Marta

Tambor, overlooking the Maracaibo lake basin, which was covered in a great sea of cloud.

At this camp we experienced typical paramo weather: intense damp, rain, and mist. In general the higher one climbs in the Cordillera de Merida the wetter it becomes. It is only in the dry months of January and February, and perhaps part of March, that one can expect clear weather. In the early mornings the sky was usually clear, and we could see right away to the Maracaibo lake, but by 8.30 or 9 a.m. the mist came rolling up from the tropical valleys below, and by 10 a.m. we were enveloped, with intermittent rain for the rest of the day. Winds are rarely strong, they are in fact the most windless and silent mountains I have ever seen. Such winds as there are blow either from the north-east or south-west, heavily laden with moisture from the Maracaibo area or from the Orinoco plains. The Paramo del Tambor, "Paramo of the Drum," derives its name from a peculiar booming sound caused by the light north-east wind, which appears to form an eddy in a crescent of the hills. Every night from this camp we could see the curious phenomenon of the "Catatumbo lights," brilliant yellow flashes flickering across the sky, like sheet lightning without thunder. They are said to be caused by some form of gas emanating from the Catatumbo river, in the country of the Motilones Indians.

The only species of *Espeletia* collected on Tambor was *E. neriifolia*, the type species of the genus, of shrub habit with broad leathery leaves. But the common *E. Schultzii* appears to flower here earlier in the year. In other respects Tambor proved an interesting collecting ground: some fine material was obtained of the rare *Centronia pulchra*, known locally as the "Mortiño," a new addition to the Kew Herbarium. This beautiful tree, with silvery-grey bark and brilliant electric blue and petunia-red flowers grows to a height of some 30 feet in sheltered ravines among thick bush. It is extremely localized. A new species discovered here was *Geranium Tracyi*,[1] of prostrate growth, with delicate pink and white flowers. *Gnaphalium paramorum* was also an addition to the Herbarium. Other specimens were *Arcytophyllum caracasanum*, *Eupatorium theifolium*, and *Liabum megacephalum*.

We returned to Merida on August 31. Our Chinese cook, who had proved utterly useless on the paramos, now returned thankfully to Caracas. In his place we engaged an Andino who, although he laid no claims to being a good cook, was more suited to mountain conditions. Our muleteer, a *Mestizo* with the same dour character as the mules themselves, had worked well and we re-engaged him for a further tour. Several days were spent in drying and making notes on the plant collection. The humid climate proved a trial, as mildew spread rapidly, and we resorted to the stove method of drying specimens.

On September 6 we left for the Paramo de Conejos, due north of Merida, starting from Egido as before. The first day we followed a steep trail up through the foothills, passing among groves of bananas and coffee bush, with patches of woodland thick with ferns and creepers. Upwards of 600 species of fern are found in the Merida district alone. Here and there we came on a tiny farmhouse, with conical high-pitched roof of thatch. The people of these

[1] Described in *Kew Bulletin*, 1941, p. 219.

parts, of mixed Spanish and Indian descent, are extremely poor and subsist on the barest minimum; 80 per cent. are illiterate and 75 per cent. diseased or suffering from under-nourishment. And this in a country which is the third greatest oil-producing area in the world, and which, until the present war, had no foreign debt. Oil is master, agriculture and other industries are neglected, and the peasants remain backward. The cost of living is extremely high, so that a peon on a wage of £2 per week can be near starvation. Rice, a basic item of diet, is all imported, with heavy duties.

Leaving the cultivated area we climbed steeply through open bush and woodlands, and in late evening pitched camp on the edge of the forest belt or *monte*. September 7 was a wearisome day. We had hoped to get through the monte and reach open paramo, but the trail was narrow and deeply trenched, and throughout the entire day we worked with machetes and stakes, having no other digging tools, to cut a way through. Camp was made in the monte with some difficulty. The following morning we emerged on to the paramo and climbed the flank of the Sierra del Norte. Merida could be seen shimmering in a heat haze 1500 metres below. The Paramo de Conejos consists of two main lateral ridges along the crest of the Sierra del Norte. There are signs of former glaciation, with rounded outcrops of rock, broad U-shaped valleys, and morainal ridges. We camped at 4000 metres and were fortunate in finding pasture for the mules. Camping on the paramos for any length of time has its own problems. Mules must often be sent down to lower levels owing to lack of grazing. Fuel must be brought up from below, for the scrub in the ravines is rarely dry. Suitable camp sites are few, because the rare patches of flat ground form catchment basins and are generally waterlogged. The worst enemy is the constant damp, and double or even treble ground sheets of heavy material are a necessity. The paramos are for the most part uninhabited, and one cannot rely on obtaining any supplies, though potatoes and milk can occasionally be obtained from an isolated cattle farm.

The *Espeletiae* on Conejos were abundant and in full bloom. September and October proved in fact to be the best collecting months, although scattered plants can be seen in flower nearly throughout the year. It was evident that the plants need some protection for maximum growth, and only reached their full height of 6–8 feet, with characteristic woody stems, in ravines or sheltered gullies. They grow in an acid soil containing no limestone. The stems of *Espeletiae* are resinous, and in that respect form the counterpart of the conifers of more northern latitudes; we had hoped to use these stems for fuel, but they need a long period of seasoning before they are of any use. The resin is used as incense in the churches of the Merida district, and by some of the Indians for stopping their teeth. The Venezuelan Government has recently experimented with the manufacture of paper from the long floccose leaves of *Espeletiae*, but as far as I could learn without much success. If any economic use could be found for these plants there is certainly an unlimited supply of material. The vernacular name for the *Espeletiae* is "Frailejón," due to the similarity of the plant, with its dense tomentum of leaves, to a hooded monk. Specimens collected on Conejos included *E. elongata* and *E. atropurpurea*, the two latter both new for Kew. While on Conejos and the surrounding paramos we heard frequent accounts of a

"Frailejón morado," or purple *Espeletia*, and made vain efforts to track it down. It was no doubt confused with *Senecio tabacon*, a common reddish-purple Composite, not unlike a large Michaelmas daisy. Prominent in sheltered places was *Chaetolepis Lindeniana* (Melastomaceae), a beautiful shrub reaching a height of 10 feet, which with its rose-red flowers resembled Scottish heather grown to a gigantic size. We had received a request from the Director of Kew to collect all species of wild potato that we could find in this part of South America, which is their native habitat, for purposes of investigation into potato diseases and for possible crossing with home-grown species. We tried to enlist the aid of the local population in this search, but with marked lack of success. They regarded the enterprise as singularly futile, and pointed out that they had large stocks of their own for sale, considerably more succulent than the miserable wild tubers.

I wished to make one camp high up on the northern flank of the Sierra del Norte, and on September 14 we moved to the Paramo de Campanerio. *En route* we crossed the Rio Gonzalez, a tributary of the Chama. It was greatly swollen by the rains and treacherous bogs had formed at the water's edge. We had some anxious moments with the mules, who sank almost to their bellies. A long steep climb followed to the crest of the Sierra. One of the mules, the oldest of the string, had already shown signs of sickening, and on this climb he collapsed, evidently affected by the altitude. The loads were shifted to my riding mule. Near the summit ridge we came on a lupin which subsequently proved to be a new species, *L. verbasciformis*; it was 18 inches high, of a beautiful deep blue, with remarkably long and woolly raceme. It was the only specimen we found of this plant during the whole seven months in the Cordillera. The woolly characteristic, a means of preventing too sudden transpiration, is a noticeable feature of many paramo plants, especially in the case of the *Espeletiae* and some of the ferns.

Camp was made at 4100 metres on Campanerio. We were lucky in finding a comparatively sheltered spot, but it was a most uncomfortable camp. Bitter cold and rain prevailed, and at one time or another the whole party was doubled up with *Mal de paramo*, or paramo sickness, an acute form of mountain sickness aggravated by the damp and sudden changes of climate, the symptoms being lassitude, sleeplessness, and loss of appetite, often accompanied by vomiting, back and stomach pains, and feverish cold. It is recognized as a distinct illness by most Venezuelans, and is a great deterrent to visiting the paramos. After this one bout of sickness my wife and I never suffered again. In common with others it has been my experience that the effects of altitude are felt at much lower levels in the Andes than in the Himalaya, a height of 4250 metres in the Andes being equivalent to about 5350 metres in the Himalaya from the point of view of general comfort and well-being. Our muleteer was so ill that he decided it would have to be his last tour with us. He subsequently joined the Merida Police Force and on one occasion was detailed to arrest us for taking a photograph of the police station, a situation which amused him as much as it did us. To complete our discomfort the camp was flooded by a sudden run-off, in spite of the deep drains which were dug round the tents at every camp.

Collecting was continued under difficulties. An interesting umbelliferous

species was *Niphogeton ciliatum*. Apart from the *Espeletiae* the Melastomacaea formed the best material in our collection from the range as a whole. *Espeletia spicata*, an addition to the Kew Herbarium, was found on bare sandy soil. A species of *Echeveria* was found growing on rocky outcrops; a striking little plant with thick fleshy leaves and tiny bell-shaped orange-red flowers, known locally as "Repollo de Montana," the mountain cabbage. Other species found included *Senecio longe penicillatus*, *Podocoma bartsiifolia*, and *Hinterhubera columbica*, a common white-flowered undershrub used locally as a cure for rheumatism. Also in the neighbourhood we found a splendid plant which proved to be a new species, *Culcitium rex*, with long stems 5–7 feet in height, culminating in tufts of brittle glossy leaves with small pale yellow flowers. This plant is closely allied to the senecios.

Two further camps were made at lower altitudes on the southern slope of the Sierra, where conditions were much better, and, on October 1, we returned to Merida by a good mule track down the valley of the Rio Albarregas, passing through thick forest. The garbled accounts of the Munich crisis which had by now reached Merida almost paled into insignificance beside the more immediate excitement of a shooting affray which had just occurred in the Plaza between the local Chief of Police and the retired Governor. Nobody was hurt, but the police station was slightly chipped, twenty-four shots having been fired in and about the entrance. The Chief of Police had been arrested and was languishing in his own cells.

The rains were still heavy, so we again postponed the visit to the Sierra Nevada and planned a tour to include a number of paramos to the west and south-west of Merida. Supplies were laid in, and on October 12 we left by lorry for La Vega, a small village 12 miles down the Chama valley, where the mules were loaded up. La Vega is in the arid belt, and the heat was stifling. Regiments of cacti dotted the grey-brown slopes; the countryside had a tortured look, withered and dry under a fierce sun. Crossing the Chama by a narrow bridge, we climbed steeply up the southern slope of the valley, which was almost devoid of vegetation and deeply eroded. The belt of thick forest, marking the fringe of the mean cloud level, so noticeable a feature of the slopes above Merida, was here entirely absent, but across the Chama valley we could see the lush green foothills of the Sierra del Norte, thick in vegetation.

Our first objective was Mucutuy, on the southern side of the watershed. Camp was made for a few days in the neighbourhood of Acequias, and on October 18 we crossed the Paramo de Acequias in dense mist and descended by a steep trail to Mucutuy at 1500 metres. Now that we were out of the Chama valley and on the southern flank of the Cordillera, we hoped to find a somewhat different flora, and were not disappointed. The first find was *Espeletia Lindenii*, on the Paramo de Acequias, not previously observed on the Sierra del Norte. The drop to Mucutuy from the paramos was abrupt, and we found ourselves in a network of narrow valleys filled with scrub and interspersed with coarse pasture; the forest was thinner than in the Merida district and considerable clearing had been done by burning. Specimens collected near Mucutuy included *Begonia rubicaulis*, *Begonia meridensis* (new for Kew), *Jaegeria hirta*, *Polygala paniculata*, and a new species of *Clusia*, a fine tree 20 feet high with fragrant white flowers.

I had planned to visit at least one of the small outlying paramos which stand out like islands among the forested hills to the south of Mucutuy. On October 24 we moved camp some 8 miles along the trail leading to Aricagua, climbing the next day to the Paramo de Las Lajas. Either no path existed or our guide for the day did not know of one. The last 1000 feet of the ascent consisted of a violent scramble up a 40° slope thick with bamboos. In the woods below the Paramos we found a most lovely plant, a creeper with fiery scarlet flowers and deep green leaves. It proved to be a new species, *Begonia formosissima*. Also in these woods we found a grove of the white-flowered *Espeletia banksiifolia*, of tree habit, growing to a height of 20 feet; this was the second collection made of the species. The Paramo itself yielded nothing of great interest.

While on this tour we had acquired a certain reputation as doctors, chiefly through a lucky cure of a badly scalded infant. On our return to Mucutuy our reputation had so far advanced that we were waited on by a deputation who implored us to lay a ghost, which apparently inhabited a derelict house and disturbed the village by its moans at night. Much disappointment was registered when we referred the matter to the local priest.

We recrossed the Cordillera by the Paramo de San José, the most interesting finds here being *Espeletia marcescens*, another white-flowered species of tree habit, and *Erigeron blepharophyllus*, both new for Kew. We then took a trail which led in a south-westerly direction along the flank of the range, crossing ridge after ridge running down to the Chama valley and passing through the villages of Pueblo Nuevo, Cambure, and Quirora. We continued as far as the Paramo de Molino. This was a much drier district than that surrounding Merida, the vegetation being coarse and scanty, the valleys for the most part bare and deeply eroded. Few fresh finds were made. Returning by the same route to Pueblo Nuevo we descended to the Chama valley at Puente Real and reached Merida again on November 14.

By the middle of November the dry weather should have set in, but the rains were if anything heavier. There were serious floods in the Valera district and landslides had occurred at several points on the trans-Andean highway. For some days all communication with the province of Merida was dislocated. The Sierra Nevada was enveloped in cloud and conditions there were obviously hopeless for the time being. On November 23 we moved to Timotes, on the eastern side of the Mucuchies pass, whence several paramos could be reached. On this tour we travelled light, taking only two pack-mules, and doing all camp chores ourselves. This was not from choice but necessity, for the servant problem had become acute. We had found the Andinos were loath to do more than one short tour on the paramos, after which they returned firmly to their villages. There is here no reliable supply of willing coolies as in the Himalaya and other mountain regions. The people are 90 per cent. agriculturists, mostly of poor physique, and tend to leave the mountains alone.

Short tours of four or five days were made to the Paramos of Niquitao, Tuñame, and Piñango, with Timotes as a base. *Espeletia spicata* was found on Piñango and also two senecios: *S. Funckii* and *S. nevadensis*, *Funckii* being conspicuous in patches of boggy ground. While in Timotes the bridge over

the Rio Motatán was swept away and we were immobilized there for some days. At the end of December we recrossed the Mucuchies pass to the village of Apartaderos, from which we visited the Paramos of Canoa and Mucubachi.

The inhabitants of the Mucuchies district are of a more purely Indian type than those of Merida, who are largely of Spanish extraction. Some of the outlying villages near Mucuchies, above 2500 metres, are inhabited by pure Indians. They are a light-skinned race, silent and reserved by nature, with straight black hair, of medium height and good physique. They are agriculturists, growing chiefly wheat and potatoes, which they trade with the lower valleys for coffee, sugar, bananas, and other tropical products. Their distinctive dress is the *Chamarra*, a woollen cape similar to the Peruvian *Poncho*, usually brown or blue with a scarlet lining. Such knowledge as we have of the ancestors of these Indians has been obtained from buried ruins and sepulchre caves, usually situated high up in the paramos. Some religious significance appears to have been attached to these remote, uninhabited regions. Stone totems have been found in the sepulchre caves, in the shape of eagles' wings, also skeletons, usually placed in a sitting position, together with various utensils and food to last for several days. Much of the investigation has been carried out by the late Febres Cordero, of Merida. There is undoubtedly a great deal still to be learned about these people. It appears that they had not reached a very advanced stage of civilization at the time of the Spanish Conquest, in no way comparable with that reached by the Incas or Aztecs, with whom they do not seem to have had any communication. They were agriculturists, planting crops of maize, yucca, beans, and potatoes. They made baskets, spun and wove cotton, made vases of baked clay, and there are traces of carpentry. They worshipped the Sun and Moon and were governed by their priests; their idols were crude, made of clay, and contained a stone which caused them to ring when shaken, the sounds being interpreted by the priests to reveal the wishes of the deities. We made a small collection of these idols on behalf of the Cambridge Ethnological Museum. The modern Indians have long been converted to Roman Catholicism, although, as the priest of Mucuchies told us, religious observance has to be leavened with a number of fêtes and festivities, in which fireworks play a prominent part, in order to make it acceptable to them. There were formerly about fourteen separate tribes, but the distinctions have now been lost. The language had certain affinities with that of the Chibcha Indians; traces of it can be observed to-day in many place-names throughout the Cordillera de Merida, more particularly in the common radical *Mucu* (Place) in such names as Mucuchies, Mucubachi, Mucutuy, etc. The modern Indians speak Spanish only. One custom that has been inherited from these Indians is the chewing of *Chimo*, a concoction of tobacco juice and *Troma* (Salts of Urao), a sticky black substance which to the uninitiated both looks and smells nauseating. It is said to have a beneficial effect on the teeth. The salts are found in a lake near Lagunillas, in the Chama valley, the only other known source being Fezzan, in N.W. Africa; these salts are antiseptic and anti-spasmodic, and have a slightly narcotic effect.

By the beginning of January 1939 the weather showed signs of becoming more settled, and on the 10th we left for the Sierra Nevada, intending on this

tour to make an ascent of one of the high peaks if time and conditions permitted. Mountaineering as such did not figure in our programme, but this was an opportunity not to be missed. We had heard of a good route leading from Mucuchies up to the eastern end of the Corona group. After two days on the road from Merida to Mucuchies, with all seven mules, we struck off southwards, crossed the Paramo del Oro, and on the second day dropped down a steep wooded valley to the little village of Los Arangures. Here a guide was obtained who knew of a good camp site within reach of the snows. On the morning of January 14 we ascended a narrow ice-worn valley running up to the north-west. The towering mass of the Pico Humboldt blocked the head of the valley. After 5 miles we branched N.N.W. up a side valley and reached the Paramo de Molina in the early afternoon. This paramo, botanically unexplored, is not to be confused with the Paramo de Molino to the south-west of the Sierra Nevada. Conditions here were excellent, a perfect camp site on a small plateau close to a stream, ample supplies of fuel, and dry weather. At night the thermometer dropped on an average 3° below freezing-point. We dismissed the guide, set the mules loose to graze (the pasture being of good quality) and settled down for a fortnight's stay. A new species of senecio *S. venezuelensis*, was discovered, 3–5 feet in height. Several species of *Espeletia* were also found, the most conspicuous being *E. Moritziana*, which grew in dense groves in a sheltered ravine, some magnificent specimens reaching a height of 10 feet.

Two abrupt ridges separated our camp from the snow massif to the west. On January 21 we prospected for a line of approach and crossed the ridges by two easy passes, from the second we looked down on the expanse of the Laguna Negra, with a superb view of a great amphitheatre of peaks beyond, including the snow-capped Corona group which consists of the Pico Humboldt (4945 metres) and Pico Bonpland (4894 metres); while La Concha (4922 metres), with its jagged arêtes, rose steeply from across the lake to the south-west.[1] The Pico Humboldt was the nearest summit, but direct approach to it from our position was cut off by an impassable cliff on the east side of the Laguna Negra. From the farther west shore of the lake a valley led up to the south-west, swinging abruptly south. We could not see the snout of the Humboldt glacier, but the valley seemed to provide a possible route. Returning to camp we waited a day for fine weather and made the attempt on the 23rd. The descent to the Laguna Negra and the scramble round the north shore proved to be a stiff obstacle race among dense bush and boulders, and took an undue amount of time. All this area bore signs of former glaciation, and the depression of the Laguna Negra was evidently at one time a huge corrie or cirque. An easy march over open ground up the valley from the west shore of Laguna Negra brought us to the small Laguna Verde, at the foot of a 100-metre wall of smooth terraced rock from which the Humboldt glacier had evidently been in rapid retreat. Threading a way up through the narrow gullies in this rock wall, with one short pitch where it was necessary to rope up, we reached the glacier snout. The surface here was only slightly crevassed, and almost level. In its higher reaches the glacier was heavily crevassed, but a route could be clearly traced, and Pico Humboldt seemed within our grasp.

[1] See map, *G.J.* 97 (1941) 74.

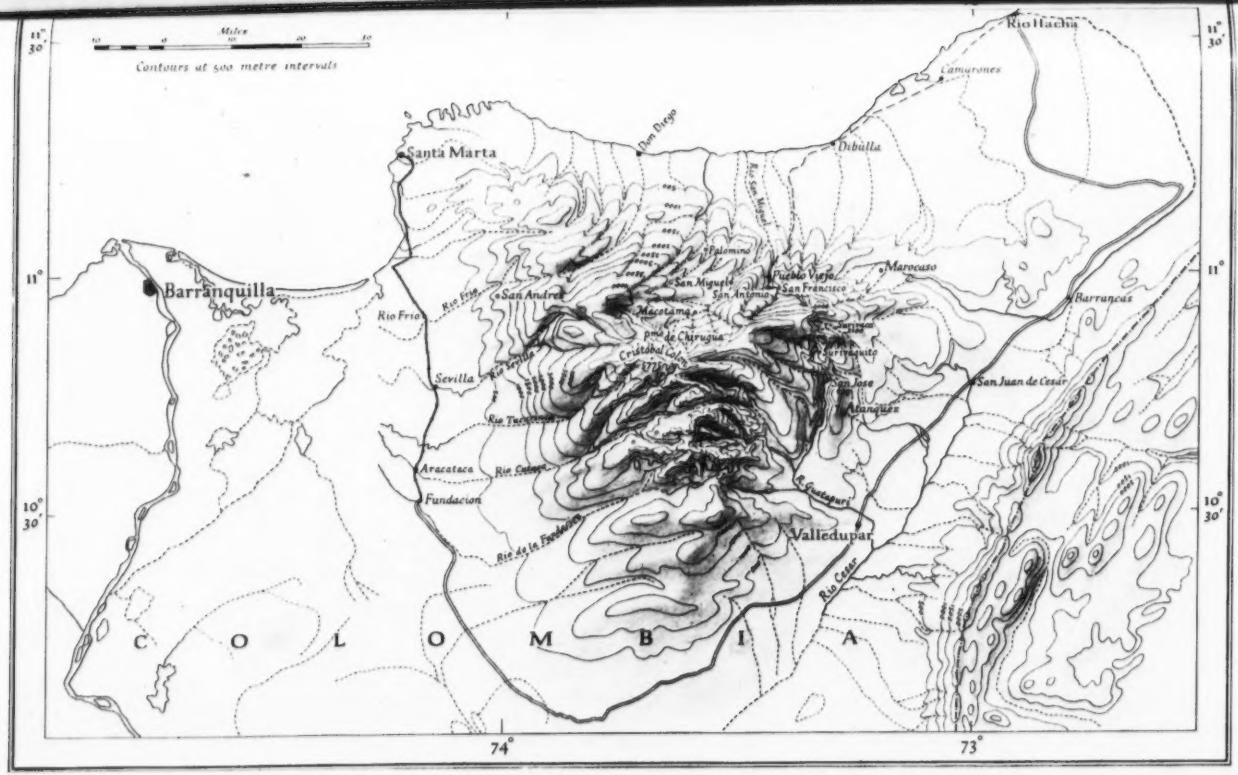
But after proceeding for half an hour thick mist enveloped us, and, as it was already early afternoon, we decided to turn back. We reached camp again fourteen hours after setting out. The Pico Humboldt was climbed by Dr. Jahn in 1911 from the south side. My wife and I were disappointed not to have reached it by this new route from the Laguna Negra.

The weather was unfavourable the next few days, and on the 29th we struck camp, crossed the Paso de Molina to the north and descended by a steep path, extremely awkward for loaded mules, to the Quebrada Mucui. Following this valley down we reached Tabay, in the Chama valley, the next day, and Merida the following morning. At the hotel we were fortunate in meeting Mr. A. E. Gunther, who, with Dr. Carl Weiss, had just made the first recorded ascent of Pico La Concha. Also staying in the hotel was Mr. A. H. G. Alston, who was making a botanical collection on behalf of the British Museum.

The next few weeks were spent in preparing and despatching specimens to England, and in making arrangements for the move to the Sierra Nevada de Santa Marta in Colombia. During this period I made a short trip alone to the Paramo del Tambor to collect seeds of *Centronia pulchra*, that vivid flowering tree, but I met with disappointment. Although it was now nearly six months since the time of full flowering, the seeds were not yet ripe. On my return from the paramo towards evening I missed the path and stumbled into the debris of a recent landslide, still in an unstable condition, and spent an anxious hour or two threading a way in mist and darkness through slabs of crumbling earth and rock.

On March 11 we left Merida and made a mixed journey by bus and train to Santa Bárbara, and thence by paddle-steamer to Maracaibo. Information about the Santa Marta range and its approaches was scanty. In 1925 Mr. A. F. R. Wollaston had gone up from Dibulla on the coast and made what was really a reconnaissance of the northern or seaward slope. At Merida Dr. Carl Weiss told us that the best approach would probably be from Rio Hacha, a small seaport on the fringe of the Goajira Indian territory. Much of the interior of the range was unmapped. We planned to cross the range to the south, making a route survey, and settle in a village for some weeks for collecting. In this part of South America, if one is relying on local transport, the success of any plan is largely a matter of luck, and delay is inevitable. One must take one's chance. We decided at any rate to make for Rio Hacha, and this meant that we must first cross the Goajira plains.

A lorry was hired in Maracaibo to take us as far as the Colombian frontier post of Maicao, and two water tanks were fitted. The Goajira Peninsula is an area of some 6000 square miles of cactus desert and grass plain, with rare water-holes and no large rivers. It is policed by a few scattered government posts. We left Maracaibo on March 7, spent the night at the village of Carrasquero, by the Rio Limón, and reached Maicao the next day. This journey is only possible for vehicles in the dry season, from November to April. There is no road; the route has been evolved by the simple process of a succession of lorries forcing their way through the scrub. It was one of the roughest tracks I had ever seen, the mud having dried hard in a series of ripples. Lorries are usually worn out after one season's work. It is only in



The Sierra Nevada de Santa Marta

Goajira woman pounding corn

Goajira Indian

the last fifteen or twenty years that "Civilisados" have entered the country of the Goajira Indians.

We camped at Maicao for a few days; although botanical collection was continued, nothing of great interest was found, the vegetation consisting chiefly of thorn scrub, cactus, and coarse grass.

The Goajiras are semi-nomadic within the confines of the peninsula. They have a few permanent villages, rarely of more than half a dozen huts, and other more temporary settlements. When a water-hole fails, as happens often in the dry season, the whole settlement moves to a fresh site, usually retaining the place-name of the previous site, a practice which makes any map purely speculative. Fights frequently occur over the possession of water-holes, but the Colombian Government has recently set up a number of wind-driven pumps working at a deeper level, thereby lessening the chief cause of friction between tribes. There are numerous tribes in this comparatively small area, for a Goajira tribe consists only of close relations. Their few laws are administered autocratically by the head of the tribe, who is often a woman. Like many South American Indians they are instinctively communistic, in a non-political sense, and tend to pool resources. Their chief wealth lies in vast herds of horses, cattle, and goats. They are almost unique in the north of South America in being plainsmen and cattle herders, the majority of Indian tribes being mountain or jungle dwellers. The grass of the plains, which appears coarse, is apparently excellent pasture, and the Goajira horses are of a particularly fine strain, with some Arab blood, evidently descended from horses imported by the Spaniards. They are much sought after by Venezuelans and Colombians, and fetch a high price in Maracaibo. The Indians, with sound business sense, will only part with the geldings. Some of the coastal tribes live by fishing, from small dug-out canoes. Turtles are caught, and the shell is traded in Santa Marta. Baroque pearls are also found, but the trade, once thriving, has declined with the introduction of cultured pearls. Cultivation is almost non-existent, and grain an imported luxury; the Indians' diet consists almost entirely of meat and milk products. Combined with their strenuous existence, this diet has given them an amazingly fine physique. They are a virile independent people, and show none of the apathy of so many South American Indians. Their birth-rate is said to be increasing. We found them hospitable and welcoming; presents are expected and exchanged as a matter of course, and must be given to every member of a settlement, and not only to the headman. Tobacco is appreciated, and we had brought a large supply of cheap cigars. It is said that if you meet a party of Goajiras, and they ask for tobacco, it is better to say you have none at all, in which case they will probably give you some, rather than to make gifts to some members of the party, leaving the others empty-handed, for then you may expect trouble from those who have received as well as from those who have not.

The Goajira huts normally consist only of a roof and poles, open on three sides, with a tiny enclosed shelter at one end. The thatch is made from cactus pith, dried and split into convenient strips. Scorpions and snakes abound in the Goajira peninsula, making it unsafe to sleep on the ground, so it has become the land of the hammock. The native hammocks are also made of

cactus fibre, with a wide mesh. The cactus is to these Indians what the date palm is to the Arab, and they have earned the name of cactus-eaters, from their custom of eating the small purple fruit of the cactus, said to be quite succulent.

Much of a male Goajira's day is spent in fashioning arrow heads, heavily barbed. The war-arrows are poisoned with a concoction of fermented scorpions and snakes, and are treasured possessions, so much so that if a Goajira only wounds his enemy he will usually track him down and forcibly extract the valuable arrow head. Metal was formerly scarce, but the advent of the motor lorry has provided a ready supply, and not only from scrap: hub-caps, mudguards, and other parts have been found delightfully detachable when the owners are away or sleeping, and rather naked-looking trucks are quite a common sight in the plains.

For a primitive people the Goajiras are peculiarly lacking in spirit-worship, superstition, or ritual. Their nomadic existence precludes cumbersome idols or totems. Drought, sickness, birth, and death are regarded as inevitable as the coming of night and day. A certain all-pervading spirit, called Yoruha, apparently lacking in personality, comes like a wind, they say, bringing changes of weather or of fortune. They have however great respect for the dead, and keep certain carefully guarded burial places, which cannot be visited by night.

The origin of the Goajiras is still something of a mystery. In customs, physique, character, and way of life they are markedly different from neighbouring Indian tribes. It is possible that they are a remnant of the now extinct Carib race, who inhabited the coastal regions of northern South America, and penetrated far up the rivers.

Two activities have lately benefited the Goajiras materially: smuggling, which also occupies a floating population of Mestizos, is carried on extensively into Venezuela. The goods, chiefly silk and tobacco, are landed by small sailing boats on the Goajira coast from the neighbouring Dutch colonies of Curaçao and Aruba, where duties are only 3 per cent., and run across the border by night, either by motor-lorry or mule train. The police on both sides are kept very busy. Only a small proportion of Goajiras engage in the business on a large scale, but those that do are extremely prosperous. One whom we met had done so well that he had sold all his cattle and invested in three motor lorries. The Indians have a distinct advantage in that they are exempt from carrying passports. A more legitimate trade in the pods of the divi-divi tree, a species of acacia, occupied a large number of Goajiras just before the war. A German firm had discovered that these pods were of great value in producing fast colours in dye-work, and a freighter took a monthly cargo from Rio Hacha.

The comparatively peaceful condition of the Goajira Peninsula does great credit to the Colombian Government, who have adopted a form of colonial administration in this outlying territory. The police control is effective, without encroaching on the independence of the Indians, who are left free to carry on their accustomed way of life. There is no exploitation and the Indians pay no taxes. In the summer of 1939 some minor riots occurred, and a few Colombian police were killed, but such troubles are infrequent. The

chief difficulties of the police lie in the control of the more sophisticated fugitives from justice who resort here from other parts of Colombia.

At Maicao we enlisted the services of a much-travelled Puerto Rican named Ramos, who wanted to visit the Santa Marta range. He had no references, such things are unknown in those parts in any case, but we took a chance on him. For some weeks he was a loyal and enterprising servant, and made himself extremely useful to us as cook and general factotum, until he landed himself in gaol as a result of a brawl with the police.

A short day's run by lorry on March 28 took us to Rio Hacha, one of the earliest Spanish settlements on the Caribbean coast, founded in 1548, and once a port of some standing, but now a sleepy, rather ramshackle little town. On inquiry we learned that there was no practicable approach to the Santa Marta range from Rio Hacha (later found to be incorrect), but that the best route lay from Fundación, at the foot of the range to the south-west, and the terminus of the railway from Santa Marta.

After a few days' delay we obtained deck-passage to Santa Marta on a small coastal trading-boat. There we were informed that there was no route either from Santa Marta itself or from Fundación to the Sierra Nevada, but that there was definitely a track from Valledupar, to the south-east of the range, where mules could be obtained. Our expedition seemed to be rapidly developing into a round trip of this elusive range. Local travel in this part of Colombia by bus and boat involves the maximum of discomfort, and we were fast becoming jaded.

Fortunately, after an unhappy bus ride from Fundación, our search was rewarded at Valledupar. Even here, barely 10 miles from the foothills, it was difficult to obtain much information about routes, but we learned that the small village of San José could be reached in two days, and from there a track was believed to cross the range to the village of San Antonio on the seaward side. Valledupar lies in the plains of the Rio César and the inhabitants, mostly Mestizos, have little contact with the Arhuaco Indians of the Sierra de Santa Marta.

Mules were hired for the stage to San José, and on April 12 we set out. The first day we rode in sweltering heat through dry scrub and cactus-covered plains, later reaching a more broken country of low, barren hills. Early on the second day, after a steady climb, we reached San José at about 600 metres, in a country of abrupt grass-covered hills, with thick bush in the ravines. F. A. A. Simons visited San José in 1878 (cf. *Proceedings* R.G.S. 1 (1879) 689–94). It was at that time, according to his report, an Indian village established by Government order with a population of about one hundred and twenty. It is now inhabited by a few Mestizo families, who have migrated there for reasons of their own, usually to evade the police, while the Indians have retired to villages higher in the mountains. This encroachment by the Mestizo population has proceeded gradually in recent years throughout the Sierra, but they rarely live higher than 1000 metres owing to the cold. Above that a purely Indian population is found.

At San José we contracted with a Mestizo, who had some influence with the Indians, for twelve oxen to carry our baggage across the Sierra. The trail was said to be difficult and unsuitable for loaded mules. San Antonio, we were

informed, could be reached in four days. A week was spent at San José while the baggage animals were assembled.

Small parties of Arhuaco Indians came in to trade. There is no doubt that these Indians are a dying race; their numbers have decreased rapidly in the last twenty or thirty years, and there are now probably not more than two thousand or three thousand in the whole Sierra. We heard that thirty years ago they had suffered severely from an epidemic, apparently influenza, which killed off one in ten of the population. These Indians are sometimes known as Kogis, but the term is mainly confined to the western and southern sides of the Sierra. The Indians recognize numerous tribal sections among themselves, but the differences are in fact slight. They are a small race, the men being rarely more than 5 feet 4 inches in height, the women about 5 feet. Though small and of apparently feeble physique, they can yet travel long distances on foot in their own mountains. They rarely descend to the plains, or to Rio Hacha and Santa Marta, where they find the heat insupportable. Nor do they have any contact with their neighbours the Goajiras, for whom they have a wholesome respect. It would be difficult to find two tribes, differing so completely in every respect, and yet living in such close proximity.

The Arhuaco dress usually consists of knee-length trousers and a long jacket, usually white and sometimes with a purple stripe. The cloth is either cotton or made from fibre produced from the agave tree. They usually carry two or three small bags, known as *Muchillas*, slung round them, while the women wear necklaces of coral and shells. They are much addicted to the custom of chewing coca, the plant from which cocaine is produced. The leaves are mixed in a small gourd with saliva and lime made from crushed and calcined shells, producing a white paste. The mixture is constantly stirred with a stick, from which it is sucked and chewed. Only the men indulge in this custom. There is no doubt that it has increased their naturally apathetic character. The coca plant is cultivated by the Arhuacos, and nearly every village has its own carefully tended plantation. The Arhuacos do not allow inter-marriage with the Mestizos, and this must lead to a good deal of inbreeding in such a small population, perhaps causing partial sterility. The presence of the Mestizos in the Sierra has had a deleterious effect on the Arhuacos. Like most American Indians they go to pieces the moment they touch alcohol, and the local rum produced by the Mestizos is a fatal attraction. They will barter their produce and cattle for one night's carouse, and be truculent and morose for days afterwards. When sober, the Arhuacos have a certain quiet, rather sad dignity; they are then friendly and easy to deal with. They have great pride of race; when speaking to us they frequently referred to themselves as *Indigenos*, the original inhabitants of the country, as opposed to the newcomers of Spanish blood.

On April 19 the oxen were at last ready, and we left San José for Surivaquito, the first stage on the way to San Antonio. Simons, in 1878, continued up the valley of the Guatapuri river from San José, up to the paramo of Chirugua, which he crossed to Macotama on the north side of the range, and so to the large village of San Miguel. We now broke fresh ground, our route climbing steeply directly from San José up a ridge flanking the Guatapuri on the east. The Sierra de Santa Marta rises from the coast to over 5700 metres

in a distance of little more than 30 miles, and drops almost as sharply on its landward side. It consists of a central snow massif running roughly east and west, with ridges radiating outwards in all directions. It is in effect rather like a gigantic open umbrella, and to traverse it one must cross rib after rib, dropping steeply to the valleys between. In the course of our journey to San Antonio we had to cross two of these main ribs. The Spaniards first crossed the range from the coast in 1573, returning with gold from the plains of the Rio César, but there is no record of the route they followed. They speak of high mountains and great cold on the way. A complete survey of the range has not so far been made. In the early summer of 1939 the American Cabot Colombian Expedition carried out an aerial survey of the central high part of the massif and the southern slopes. Owing to the misty conditions which so often prevail the mapping of the entire massif was not attempted. The sketch-map accompanying this account is based on the Cabot Expedition's map (*Geogr. Rev.* 31 (1941) facing p. 639). From San José we ran a compass traverse to San Antonio, to connect with Wollaston's 1925 route (*Geogr. J.* 66 (1925) 97). The first day's march was cut short owing to a mishap with one of the oxen: crossing a steep valley one of the loads collided with a rock, and a stray splinter caused the animal to run amok. He disappeared into the bush, strewing his load on all sides. Fortunately, no great damage was done, but some time was spent collecting scattered pieces of equipment.

The climb was continued early next day, at first through open bush, and then steeply through forest. After some 8 miles we reached open country, the beginnings of the paramo, and following the crest of the ridge reached the small village of Surivaquito, at an elevation of 2500 metres. This was the first Indian village reached on this route; it consisted only of a dozen huts, quite half of which were uninhabited. This was the case in most of the Indian villages we visited; it was not entirely due to the decreasing population, but partly to the Indian custom of moving from one village to another for a few days, so that at times a village may be crowded out and at others almost deserted. Families often own two or three huts, each in a different village. The Arhuaco huts are usually circular, 8–15 feet in diameter, made of mud and wattle on a framework of wooden posts, with a conical thatched roof. The roof is usually made on the ground and lifted bodily into position.

As we had good quarters at Surivaquito a day was spent collecting in the neighbourhood. The only species of *Espeletia* found was *E. glossophylla*, and it appeared to be the only species growing in this part of the Sierra. Among the undershrubs *Hinterhubera columbica* was common.

On April 22 we ascended over open paramo to the Paso de Surivaca (3500 metres), which we crossed in thick mist, and dropped by a steep path through light forest to Surivaca, a larger village of twenty huts. One of the huts was much larger than the others, with a collection of broken pottery and tattered flags on the apex of the roof. This was the house of the *Mama*, who has a position equivalent to a witch doctor and holds great authority over the tribes. A Mama is resident in each large village; his house is strictly guarded and may not be entered except by certain attendants. The Mama himself is rarely seen; he apparently spends most of his time in the house, but on occasions will make a tour of the district. On these tours he visits certain significant

points, usually the summits of hills or the heads of valleys, which are marked by flat stones to form seats, some of them with a back rest, and often placed in a circle. In front of each seat groups of small round white stones are placed, the number of the stones indicating the rank of the occupant, three stones being the largest number in a group. Meetings are held at these points, and petitions made to the Mama, who also blesses the crops and propitiates the gods to send fair weather. It is said that sacrificial rites are held, and dried blood has been seen on the stones. These stone-circles are also used as meeting places by the village elders, a sort of primitive agora. One such meeting-place lay just outside the village of Surivaca, and I was able to photograph it secretly while the mules were being loaded, for the Indians did not like one to approach too close. It was difficult to obtain many details about the functions of the Mama or the Arhuaco religion, as the Indians are very secretive on the subject and the Mestizos did not know much. The latter told us that at certain seasons of the year, in the spring and at harvest time, they had from a distance watched dances at the stone-circles when the Indians wore collars and chains of gold and appeared to be playing with a large ball of solid gold, which they tossed in the air. This gold ball may have some connection with the worship of the Sun-God. The houses of the Mamas were also said to contain gold ornaments. Gold is not now found in the Sierra, and it is evident that the golden objects are relics of the extinct Tairona Civilization, a much higher culture which formerly flourished in the Sierra. The gold may have come originally from the plains of the Rio César. The office of the Mama, we were told, is hereditary, and each prospective candidate undergoes a long period of training, during which he may not touch meat or salt, and eats only rice and vegetables. Every Arhuaco, male and female, wears a small cord round one or both wrists, placed there by the Mama at birth. The purpose of this was obscure, but appeared to be connected with initiation into the tribe. Catholic missions have long been established in the Sierra, but, except in the south-west, they appear to have little effect. There are small churches in one or two of the larger villages on the seaward slope, visited at long intervals by Dominican monks from the monastery at Rio Hacha. Baptisms and marriages are carried out, but as soon as the visiting priest has disappeared the Indians revert to their native practices.

At Surivaca there was another hut almost as large as the Mama's, but oblong in shape; this was the *cansamaria*, the communal sleeping quarters of the men of the village, married and unmarried. Husband and wife never sleep in the same hut. The remoter settlements, inhabited by single families, consist of pairs of huts one being the woman's, where the cooking is done, the other the man's. Meals are usually eaten at the threshold of the woman's hut. In the cansamarias a fire is kept going night and day. The Indians sleep lightly, like wild things, in short snatches of two or three hours, waking at intervals to talk and tend the fire.

Surivaca stands on a small plateau at the junction of two valleys, a path leading down the main valley thus formed to San Juan de César to the east. Our route to San Antonio followed the right bank of a steep narrow valley to the north-west. The path was very rough and at times almost non-existent, and we had some difficulty negotiating the worst stretches with our bulky

Arhuaco Indian from San Francisco, Colombia

Arhuaco Indians, with "muchillas"

Arhuaco village, Sierra Nevada de Santa Marta

Loaded mules crossing river near Valledupar

Indian bridge at Pueblo Viejo, Colombia

loads. After some 5 miles we crossed the valley to the left bank and climbed even more steeply to the pass of Nabulgakha. This pass lay at 4000 metres just above the extreme limit of vegetation. On the farther north side ice-worn rock ridges fell away precipitously to a wide cirque, at the bottom of which lay a small lake. The descent lay over rock slabs; it began to rain heavily and on the slippery rock the oxen made slow progress, often having to be assisted down inch by inch, held by the tail as well as the head. As a result we did not reach a village that night, but camped on a tiny plateau near the head of the valley. It was a difficult day's march. The Indian ox-drivers gave trouble throughout the journey; they would not work unless given a large gourd of rum, carried by the leading driver. Frequent halts for refreshment were made during the day, and towards the end of each march the oxen were usually left to fend for themselves, while their drivers raced ahead, like hounds on a scent, to catch up with the leader and join in the evening's carouse. My wife and I, bringing up the rear, often spent the last few miles rounding up stray oxen from the hill-side. It was a haphazard method of progress, but apparently the only one with these irresponsible people. The Mestizos told us the only way to get the Arhuacos to do a job was to make them drunk, when they would work without being aware of it.

After another day spent collecting, we continued down the valley of the Rio Ancha and reached the large village of San Francisco at midday on April 25. This village, of over one hundred huts, was situated on the right bank at 1500 metres near the upper limit of wooded country. The Indians here wore a head-gear peculiar to the village, a wide-brimmed straw hat with a high crown. The Arhuacos as a rule either go bare-headed or wear a small woven cap rather like a balaclava helmet. At San Francisco we were met by a party of Mestizos who had heard of our coming, and a lunch of plantains and rice was laid out on banana leaves in one of the huts. Their welcome was not entirely disinterested as they had brought mules which they offered to hire to us at an outrageous price for the rest of the march to San Antonio, and there was much chagrin when we refused. From San Francisco a good track led down through light woods, thick with ferns of several species; the open stretches of the hill-side were dotted with Easter lilies.

San Antonio, we found, was only the shell of a village, having been burned several years ago by the Indians, during a dispute with the Mestizos. The inhabited village was Pueblo Viejo, 2 miles farther on. The population is now purely Mestizo, the Indians coming in only to trade. We hired a small hut and decided to make our base there for the next few weeks, as it was the junction of several tracks. Pueblo Viejo lies at the upper limit of the forest zone, at a little over 1250 metres. There are four main vegetation zones in the Sierra: first an arid belt, extending up to about 300 metres with little rainfall, and thickly covered with cacti and xerophytic scrub; secondly, a belt of dense tropical forest, up to about 1250 metres; then a rather drier belt of light woods, shrubs, and coarse grassland up to 2300 or 2450 metres, this belt being inhabited by the Indians; and finally the paramos, extending to the limit of vegetation at 4250 metres. These zones are of course further subdivided.

Our stores were now running low, and as there was little to be obtained at Pueblo Viejo beyond plantains, sugar, and a few eggs and maize meal, we

sent Ramos down to Dibulla on the coast, a day's journey, to buy supplies. We waited expectantly but he failed to return. We decided to give him a few days' grace, and on April 5 set off on a week's tour to San Miguel and Macotama, villages visited by A. F. R. Wollaston in 1925, taking three baggage-oxen and two Mestizos.

At San Miguel we had a rather mixed reception from the Indians. There were the usual requests for rum, and when these had been satisfied we were told we were quite welcome to continue our journey up the valley, but on no account were we to visit or photograph a certain lake in the paramos, above Macotama; this, they said, was the home of the rain-goddess and the source of water for the whole of Cólombia. If we photographed it the rain-goddess would be disturbed and there would be drought for several years to come. Further, would we inform the Government at Bogotá that they and the Mama were doing all in their power to keep the supply going by appeasing the goddess. We assured the headman we would leave the lake strictly alone.

San Miguel is a large village of about one hundred huts, surrounded by a wall with a gate at either end. Only about one-third of the huts were inhabited, the epidemic of thirty years before having been particularly severe here. The route from San Miguel to Macotama is marked by flights of rough stone steps, obviously of great antiquity. The blocks are large and much worn. They were noted by Wollaston on his journey, and are said to be relics of the T-Civilization. There are also signs of former irrigation canals. The whole area must certainly have been in a much more prosperous state than it is now. The Arhuacos of to-day could never undertake such works.

We spent a few days collecting above Macotama, in typical paramo country, and returned to Pueblo Viejo on May 13. There was no sign of Ramos. Shortage of supplies and cash had now become acute, and we decided that I must make the journey to Santa Marta and back, where we had arranged credit, while my wife remained with our possessions at Pueblo Viejo. It was a difficult problem, but it was preferable for her to remain in a friendly village rather than to travel alone. We planned on my return to make the journey to Palomino (previously visited by Wollaston), and continue west along the seaward slope of the Sierra by a path which we were told came out near El Frio on the Santa Marta–Fundación railway. This path was said to be quite unsuitable for baggage-animals of any sort, and the journey would have to be made on foot. The Arhuacos do not as a rule carry loads, and it looked as if some diplomatic work lay ahead.

I left for Santa Marta at the end of May and did not return till the middle of June, after a journey which ranks as the most acutely uncomfortable in my life. At Dibulla there was considerable delay in finding a west-bound boat. The boat, when it was ready, was a large motor dug-out loaded nearly to the gunwales with bananas, on which the passengers crowded, sometimes lying on top of each other. Sleep was impossible. On the return journey we narrowly escaped shipwreck; a heavy sea got up and a landing was made on the coast with difficulty at 2 a.m. I arrived back at Pueblo Viejo in a rather exhausted condition. Two days later both my wife and I went down with fever, apparently a form of relapsing fever. After this we were quite unfit for strenuous travel for some weeks, and abandoned the journey to Palomino.

When we had recovered a little we made the journey to Santa Marta in July and spent two weeks convalescing.

To all intents and purposes this was the end of the expedition. At the end of July we travelled by air to Bogotá, and from there made a short tour of ten days to the Tolima range in August, via Honda and Fresno. *Espeletia Hartwegiana* was collected on the Tolima Paramos, but there were no fresh discoveries, although the collection profited by some rare specimens. The outbreak of war curtailed our activities and we took passage to England from Buenaventura at the beginning of September.

In conclusion, I should like to express my thanks to the authorities at the Royal Botanic Gardens, Kew, for their constant cooperation and for their determination of the species collected.

DISCUSSION

Before the paper the PRESIDENT (Field-Marshal Sir PHILIP CHETWODE) said: The paper on "Journeys in the Northern Andes" was to have been read by Mr. Hanbury-Tracy. Unfortunately, like so many others just now, he is suffering from influenza. His wife however is going to read her husband's paper. I am sure we are all most grateful to Mrs. Hanbury-Tracy for so doing.

Mrs. Hanbury-Tracy then read the paper printed above.

The PRESIDENT: It only remains for me to thank Mrs. Hanbury-Tracy on your behalf very much indeed for the wonderfully interesting evening she has given us, and for stepping into the breach when her husband is so ill.

Dr. Hugh Scott sends the following contribution:

There is a remarkable convergence in the evolution of some of the high-mountain plants of these northern Andes, and of the high-mountain flora of tropical Africa. In two continents thousands of miles apart the conditions at great heights above sea-level have produced an extraordinary resemblance in the habit of growth. Some of the excellent photographs shown in the lecture might almost have represented the arborescent senecios and giant lobelias of Ruwenzori, Kilimanjaro, and other African mountains. In both cases there are rosettes or clusters of long, stiff, sword-like leaves. The resemblance is specially noteworthy in the case of the Andean *Espeletia* and the African tree-senecios. Both are members of the same natural order (Compositae), but whereas the tree-senecios have gradually developed gigantic stature in comparison with their relatives, the groundsels and ragworts, in *Espeletia* it is thought that evolution has proceeded in a contrary direction, and that they have become dwarfed in comparison with a larger ancestral form. I am indebted for this last piece of information to my colleague, Mr. A. H. G. Alston, the botanist, who was present at the lecture and was also collecting plants in Venezuela for the Natural History Museum at the same time that Mr. and Mrs. Hanbury-Tracy were there. The two expeditions were, indeed, together for some days.

Another matter which struck me, as an entomologist, was the prospect of a rich yield awaiting a collector in the probably highly peculiar insects which may be associated with these strange plants, in particular any which live in the narrow angular spaces (the leaf-axils) between the bases of the leaves. The study of them might well add a chapter to the natural history of the large association of insects and other animals living in this kind of habitat, which comprises the leaf-bases of palms and pandanus in the Old World, and of the epiphytic Bromeliaceae in the New World tropics.

MINERALS AND PLANNING

S. H. BEAVER

Evening Meeting of the Society, 20 November 1944

IT is as well to begin by defining the terms of the title. The word "mineral" is here used for any natural inorganic substance which is extracted from the accessible portions of the earth's crust for some economic purpose. The extraction may be by what is ordinarily termed mining, *i.e.* underground operations, or it may be by quarrying, *i.e.* surface excavation (sometimes referred to as opencast mining); or through a borehole as in the case of brine for salt extraction, or of petroleum. This paper is mainly concerned with the winning of mineral wealth by quarrying, though an attempt is made broadly to survey the whole field of mineral working as it affects town and country planning.

It is perhaps unnecessary to define planning as such, but as far as mineral working is concerned it means the formulation of principles, policies, and detailed programmes for the orderly and expeditious extraction of minerals in accordance with both local and national interests and in such manner as to interfere as little as possible with other forms of land use.[1]

The minerals obtained by underground mining fall into two broad classes: the stratified and the unstratified. Unstratified minerals are mostly metalliferous ores, such as copper, tin, lead, zinc, and hematite iron; while the stratified group includes coal and the bedded ironstones.

The minerals obtained by quarrying are usually called "rocks" by the mining engineer to distinguish them from the ores with which he deals underground, but the use of this term is inadvisable since the geologist also employs it to describe any or all of the stratified or igneous mineral constituents of the earth's crust, including poorly consolidated deposits like sand and gravel. There are many quarried minerals, some being unstratified, such as the igneous and metamorphic rocks, granite, basalt, etc., but the majority are stratified, such as limestone and chalk, sand and sandstone, clay and shale, gravel and those bedded ironstones which are sufficiently near the surface to be quarried economically rather than mined.

The sum total of mineral wealth won annually in Great Britain amounts to a very large tonnage, of which coal, obtained in peace-time almost exclusively by underground mining, represents a high but decreasing percentage. During the twenty years inter-war period, 1919–38, nearly 8000 million tons of minerals were won, of which coal comprised about 6000 million tons, or 76%.[2] The output of coal remained fairly steady during this period, apart from the years of industrial unrest, but owing to the increasing output of less valuable quarried minerals, the proportion of the total tonnage represented by coal

[1] The views expressed in this paper are those of the author, and in no way represent the opinion of the Ministry of Town and Country Planning.

[2] Note on statistics: the three main sources of official statistics, published by His Majesty's Stationery Office, are the Annual Report of the Secretary for Mines, the annual List of Mines, and the triennial List of Quarries.

declined sharply, while the value remained relatively high, as the following table shows:

	1920	1938
Tonnage of all minerals	282 million	351 million
Tonnage of coal	229 m.	227 m.
Percentage, coal	84%	65%
Value of all minerals	£427 m.	£215 m.
Value of coal	£397 m.	£189 m.
Percentage, coal	93%	88%

Coal mining conflicts with other forms of land use partly through the huge spoil-banks which usually accumulate at or near the pit-head, but mainly through surface subsidence caused by the extraction of a coal seam or seams several feet in thickness. As our coal mines are gradually extending their operations under rural rather than urban areas, and mining is on an average getting deeper, so the problem of subsidence is in general getting no worse. The problem presented by quarrying however has increased enormously since the 1914–18 war, as the following figures will show.

Between the two wars the increase in output of almost every quarried mineral was very considerable, and the total tonnage obtained by opencast working rose from about 34 million tons to well over 100 million tons. The more important individual increases are as follows: Limestone (used for lime, cement, agriculture, building stone, road metal, and flux) rose from 7 million tons in 1921 to 20 million tons in 1939; Chalk (used for lime, cement, and agriculture) from 3^{1}_{2} millions to 10^{1}_{2} millions; Brick Clays (for building-bricks, tiles, etc.) from 9^{1}_{2} millions to 23 millions; Sandstone (for building-stone, paving, etc.) from 2 millions to 3·8 millions; Igneous Rock (for road metal, building, etc.) from 4 millions to 6^{1}_{2} millions; and, most striking of all, Sand and Gravel (used for concrete and other building and road-construction works) from 2 millions in 1921 to 33 millions in 1939.

The greatest increases, clearly, have been shown by those minerals which contribute to modern civil engineering operations, especially the manufacture of concrete and the surfacing of roads; and while the output of brick clays has likewise expanded considerably, that of the out-moded slates and paving-flags has increased but slightly or has actually, if a rather longer period be considered, decreased. The following table compares the total output of various quarried minerals over two nineteen-year periods, one before the 1914–18 war and the other between the 1914–18 and the present wars.

	1895–1913 *	1920–38 †
Clay	208·7 m. tons	453·4 m. tons
Limestone	225·5	343·4
Chalk	82·7	155·3
Igneous rocks	103·5	217·2
Gravel and sand	37·8	220·0
Sandstone	92·2	87·9
Slate	7·0	6·9

* From R. L. Sherlock, 'Man as a geological agent' (London, 1922), p. 73.
† Compiled from Annual Reports of the Secretary for Mines.

The increasing output has been achieved very largely by the mechanization of quarrying operations, as may be judged from Fig. 1, and from the following table which sets the number of quarries against output for the more important minerals in the years 1922 and 1937.

Mineral	*No. of Quarries*		*Output (tons)*		*Average output per Quarry*	
	1922	1937	1922	1937	1922	1937
Ironstone	79	63	4,480,072	10,882,000	56,709	172,730
Igneous rock ..	1310	896	5,982,739	10,469,762	4567	11,685
Limestone	1262	913	9,425,131	18,963,910	7548	20,771
Chalk	213	176	3,024,448	10,218,049	14,199	58,057
Clay, shale, etc. ..	777	930	6,400,149	25,667,686	8237	27,600
Gravel and sand ..	638	1419	2,058,539	20,442,041	3226	14,407

Compiled from the List of Quarries for 1922 and 1937, and Annual Report of Secretary for Mines for the same years.

The regional expansion in output, with its accompanying changes in the number and size of quarries, is not by any means even. From an analysis of the Quarries Lists for 1922 and 1937 it appears that thirty-six counties or sub-counties [1] increased the number of their quarries between these two years, while twenty-one decreased. The most notable increases were in the Thames Basin counties owing to the great development of gravel digging. Middlesex and Essex each more than trebled their 1922 numbers, while Bucks, Berks, and Herts more than doubled theirs, as also did Suffolk. The most striking decreases were in Northumberland, Cumberland, and North Riding in the north, in Glamorgan in Wales, and in Cornwall, Devon, and Somerset in the south-west. Here the extinction of the smaller building-stone and roadstone quarries is clearly reflected. It is curious that Northamptonshire, with so much expansion of ironstone quarrying, should figure in the list of decreases; but this is partly owing to the extinction of the smaller clay-pits and limestone quarries, and also to the increasing concentration of ironstone working on larger mechanized pits.

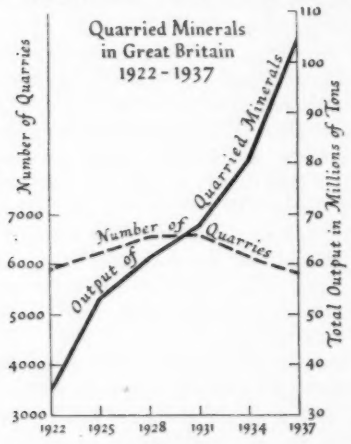


Fig. 1

From the foregoing it is clear that problems of considerable magnitude have arisen in connection with the relation of quarrying to other forms of land use; problems which were almost non-existent at the end of the 1914–18 war, and which were scarcely appreciated when the Town and Country Planning Act of 1932 was formulated.

The list of common quarried minerals includes all the ordinary rock types, and quarrying is thus very widespread. There is scarcely a single geological

[1] Sub-divisions used in the Mineral Statistics, *e.g.* North and South Staffordshire, East and West Gloucestershire, etc.

formation in the whole stratigraphical succession which is not capable of economic use, given a local demand. The number of working quarries in Great Britain in recent years has averaged over six thousand, but the number of disused excavations must run into tens of thousands. Not all these widespread deposits are of equal value however either technically or economically, and in consequence there are only certain localities where quarrying has developed to such an extent as to interfere seriously with other forms of land use.

Not all quarrying is offensive, and a very large part of our quarrying industry need raise no serious problem; in many cases quarrying is an eminently suitable form of land use, providing useful rural employment and interfering with neither agriculture, scenery, or development. It is important to realize, too, that quarrying is an essential industry, in which much capital has been invested, and that it has just as much right to the use of land as have farming, housing, or manufacturing industry. But certain types of quarrying may cause a great wastage of our national land, by rendering large areas virtually incapable of any further economic use, and offensive to the eye. Moreover the existing powers of control over mineral working, involving as they do the payment of full compensation if permission to work a deposit is refused, are quite inadequate to prevent the spread of devastation, and quarrying thus succeeds in competition with other forms of land use which might be far more desirable.

A few general remarks on the various types of quarries, and the restoration problems which they present, may suitably precede an account of the distribution of the more important quarried minerals, and of the major problem areas.

Quarries are either large holes in the ground or excavations of hill-sides, and in the vast majority of cases complete restoration of the surface to its original level and use is obviously impossible. The question of how far effective restoration is feasible depends on three main geological features of the quarry: first, the thickness of the mineral deposit which is being worked; secondly, the thickness of the overburden which covers the mineral deposit; and thirdly, the relation of the underground water-table to the floor-level of the quarry. It depends also on the methods by which the overburden is removed and dumped, and on whether or no the top soil is retained separately from the rest of the overburden. A few examples will illustrate these points.

A thin stratum covered by little or no overburden presents a comparatively easy restoration problem. The top soil can be removed mechanically or by hand, and replaced on the worked-out ground, so that in favourable circumstances crops may be growing only a few yards behind the quarry face, and at a level lower by the thickness of the mineral which has been extracted, as, for instance, in the south Lincolnshire section of the Northampton Sand ironstone field. Formerly the whole of the area worked for ironstone in Northamptonshire and the adjoining counties was restored to farming in this way, but the increasing overburden and the now universal use of mechanical excavators have led to the serious problems which are analysed below. Similar conditions are found in the brick-earth areas of the Thames valley and north Kent.

A thick stratum, say 20–50 feet or more, will leave a large hole, whether or no there is any overburden; it may be very difficult to restore the pre-existing surface, but the hole may be used as a controlled rubbish tip, and the scar may be hidden with vegetation. A very large proportion of our quarries are of this character. Quarries in the softer rocks, such as sand, clay, and chalk, will weather and take vegetation more rapidly, with or without human aid, than the older limestones and sandstones, or igneous rocks; unfortunately these last frequently occur in areas of good scenery.

A very thick overburden removed to uncover a comparatively thin seam of mineral will cause great disturbance, but no great change of level. Working is bound to be mechanical, and the problem of producing a level surface after the extraction of the mineral is largely a mechanical one, which is discussed in more detail below. This is the problem presented by the deeper ironstone workings in Northamptonshire and Lincolnshire, and by the war-time open-cast working of coal.

If the normal underground water-level is near the surface, a quarry which penetrates below this level will become flooded, especially when working ceases, as for example in many old clay pits. More serious however are those gravel and sand pits which are worked wet, *i.e.* by dredging or pumping the mineral from an artificial lake. Such lakes may be almost impossible to fill if, as in the Thames valley, some 20–30 feet of gravel have been removed; for only carefully selected material can be tipped, to avoid water pollution and the breeding of mosquitoes.

There follows a brief survey of the major quarried minerals and the planning problems to which they give rise. The jurisdiction of the Ministry of Town and Country Planning ceases at the Scottish border, and in consequence my remarks will be confined to England and Wales.

Gravel

The figures already quoted have shown that gravel quarrying has had a more spectacular development during the inter-war period than any other mineral. The output tonnage increased ten-fold between 1922 and 1937, and the figure for the latter year, 20 million tons, has been doubled again since the outbreak of war, so that gravel takes second place to coal by weight. When it is remembered that most gravel pits are comparatively shallow and so spread rapidly, and that a large part of the output is obtained from wet pits, the extent of the problem may be realized.

One of the greatest difficulties in controlling gravel working is the low value of the mineral by weight (*2s 7d–3s 9d* per ton in 1938), which greatly restricts its marketable area. Thirty miles is probably an economic limit for road transport of gravel, in most cases. Very few pits have rail transport available, as they are mostly too ephemeral to warrant the expense of construction sidings or mineral lines; moreover the lorry can give pit-to-site facilities. Hence quarrying is more widespread than it might otherwise be.

Gravel is one of our most widely distributed minerals. It occurs in various forms and in beds of different ages, but the vast majority of the quarries are in superficial deposits, of Pleistocene and Recent age, *i.e.* glacial gravels and

Phot. Geol. Survey. Crown Copyright

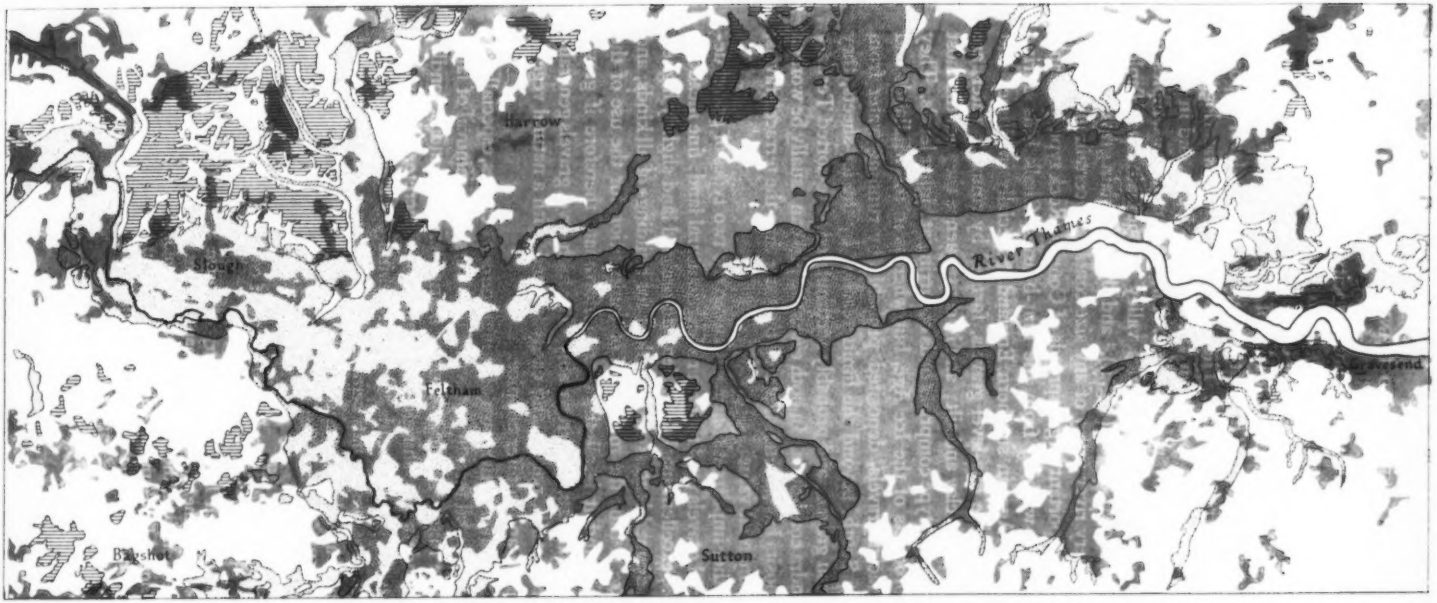
Gravel pit in the Boyn Terrace, East Burnham, Bucks

Phot. Feltham Sand and Gravel Co.

Wet gravel pit and ballast barge in tow, Feltham, Middlesex

Phot. Feltham Sand and Gravel Co.

General view of gravel plant, Feltham



GRAVELS OF THE LONDON REGION

Scale : 6 miles = 1 inch

Miles

5 0 5 10

Plateau Gravels

River Gravels

Developed Land

Fig. 2

river terraces. Pebble beds of sufficient homogeneity occur only occasionally in the solid formations; examples are the Bunter Pebble Beds (Triassic) of the West Midlands and the Pliocene Crag of the Norwich area.

For the sake of simplicity the 10-mile map of gravel deposits [1] shows only two main types of occurrence. The first comprises the low-level deposits, generally in the form of river terraces. These usually become waterlogged as soon as the excavation reaches more than a few feet in depth, and in consequence tend to be worked by wet methods. The outstanding examples of this type are the gravels of the Thames valley (Floodplain and Taplow terraces) above and below London (Fig. 2),[2] and the floodplain gravels of the Trent, but almost every river valley of any size contains a certain amount of gravel, and there are important larger spreads of Coombe Rock type, probably due to extensive down-washing from the flint-bearing Chalk hills during snow-melts in the Ice Age, in southern England, especially in Sussex and Hampshire. Most of these low-level gravels, formed by running water, are fairly clean and free from clay and silt; and in consequence they are the most economical. The second type comprises beds occurring at higher levels. They are probably all products of the Ice Age, but whereas in the Midlands and North they are glacial gravels, deposited probably by running water from melting ice, in the South, beyond the limits reached by the ice-sheets, they are known as plateau gravels, and probably accumulated as re-sorted Tertiary material under tundra conditions. In both cases the pits can usually be worked dry, but as the deposits have been less sorted by water than the terrace gravels, they have less commercial value.

There is one further important contrast between the two types of gravel deposit. The low-level gravels tend to form rich agricultural land: fine meadows at the lowest levels, excellent market-garden and orchard land slightly higher. The flat and well-drained land is also excellent for buildings of all kinds, and for airfields. There is thus the maximum of competition for the use of the gravel-bearing land, and it is all the more unfortunate therefore if gravel working destroys the land surface irreparably. The high-level gravels generally carry poor and sterile soils, porous and easily leached, with a natural vegetation of heath or birch-and-conifer coppice.

There is abundant gravel in the form of shingle on our beaches, especially on the south coast, but several factors restrict its use. First, the removal of large quantities of shingle might result in serious marine erosion, and secondly, the salt content renders the shingle unsuitable for concrete. Working is almost confined to the great spreads of gravel behind Dungeness and near Eastbourne, which are somewhat remote from a large market. Several million tons of gravel are obtained annually by dredging from large estuaries, notably those of the Thames and Severn, but this obviously has no effect on the land.

The principal use of gravel is as a constituent of concrete. Road construc-

[1] Prepared by the Research Division, Ministry of Town and Country Planning, and shown in manuscript at the meeting. The map is being prepared for publication, in a slightly modified form, with the cooperation of the Geological Survey.

[2] On Fig. 2, "developed land" means substantially built-up land, that is, occupied by buildings or in use in connection with existing buildings.

tion and building operations consume the bulk of the output, hence the rapid increase in output during the inter-war period. Production was accelerated in 1939 by air-raid precautions, and the war-time programme of airfield construction has consumed many millions of tons. The war years in fact have witnessed a change in what might be called the centre of gravity of gravel digging. Whereas in 1938 the six metropolitan counties, Middlesex, Essex, Surrey, Kent, Buckingham, and Hertford, produced 42% of the output of Great Britain, this has been reduced to something like 10%, while the East

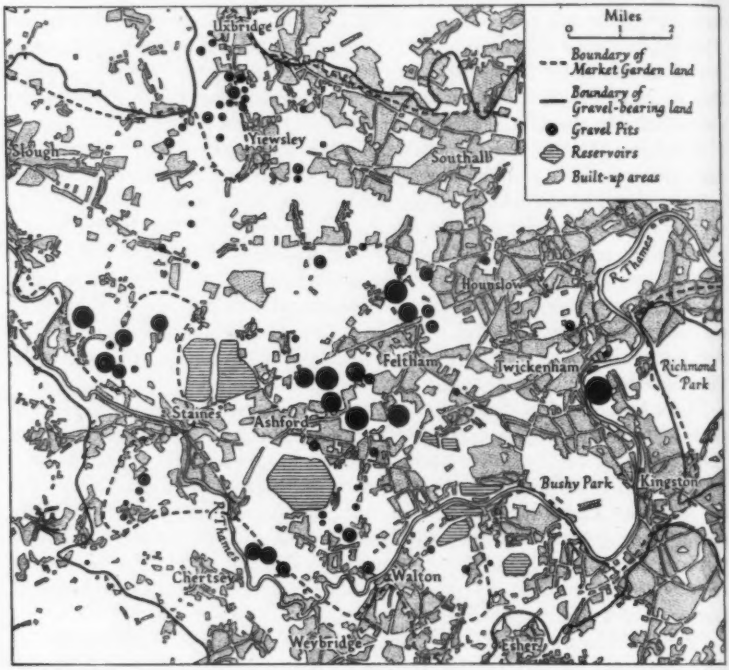


Fig. 3. Gravel and market-garden land in West Middlesex and South Bucks. The gravel pits are graded in accordance with their output in recent years

Anglian counties, Norfolk, Suffolk, and Essex, have jumped to over 20%, and Norfolk was in 1943 the leading county in gravel output, with Essex, Lincolnshire, and Suffolk next in order. The effect of airfields and gravel pits on the agriculture of this fertile part of Britain cannot yet be told, but the war will undoubtedly leave behind a melancholy series of derelict pits. It does not mean however that the danger is past in the Thames valley; on the contrary, if airfield building in the immediate vicinity of London has been less important than elsewhere, general reconstruction after the war will no doubt create a boom in gravel in Middlesex, Bucks, Essex, and the other metropolitan counties, that will only increase the planning problems in that area.

Fig. 3 shows, for the area west of London, the relation between the gravel-bearing land and the area delimited by the Land Utilisation Survey as first-class arable (market gardening) land.[1] There is a remarkable coincidence except in the lowest Thames-side areas which are too wet for horticulture. The figure shows also the extent of the built-up areas and the location of the gravel pits.

Perhaps the worst affected area of all is the Feltham Urban District. This area is entirely underlain by gravel, and suburban expansion is hemmed in on almost every side by lakes, or by land owned by gravel-working companies and destined to be converted from market gardens into lakes. The largest lake so far is ¾ mile long and ½ mile wide, and over 20 feet deep.

The depth of gravel extracted from these pits averages about 20 feet, and the output is thus about 30,000 tons per acre (reckoning a cubic yard of gravel as about 24–25 cwts.). This means that in Middlesex alone over a hundred acres must have been rendered derelict in the single year 1939, and probably 1000 acres during the inter-war period. Much of the gravel dug in Britain has a depth of less than 20 feet and in consequence uses still more land per ton of output. An estimate of 1000 acres a year as the total area devastated by gravel working at the 1939 rate is probably not far wrong, and very little restoration of gravel pits has been attempted. This figure compares with less than 200 acres estimated by the Kennet Committee to be devastated annually by ironstone workings.

Gravel pits in the Thames valley add nothing to the beauty of the landscape. Their buildings are strictly utilitarian, unpleasant in appearance, and noisy in operation. The pits form vast lakes, from 10 to 100 acres in size, distributed in haphazard manner over the unbuilt-on part of the region. When exhausted they are usually in an untidy condition, with derelict buildings left standing. Willows, reeds, and other vegetation grow over the margins of the pits, and over such islands as have been created by dumping rejects or overburden or have been left because of some defect in the deposit. A few of the lakes have been stocked with fish and are leased to fishing clubs; for a very few there may be a possible future as lidos. The accumulation of water in the lakes lowers the water-table beneath the surrounding land, with deleterious effect on the agriculture and especially on orchards. And meanwhile every extension to gravel working eats up more of the land which is London's prime source of fresh vegetables. Clearly the problem is most pressing. The Minister of Works and the Minister of Transport want the gravel; the Minister of Agriculture wants the market gardens; the Minister of Health is concerned about the condition of the lakes and water supply; further, there will no doubt be new building activity, while the Metropolitan Water Board is anxious to construct more reservoirs; and finally, the Minister of Town and Country Planning has to ensure that the land is used in the manner most likely to be in the local and national interest.

Ironstone

I do not wish to say much about ironstone, for several reasons. In the first place it is the best publicized problem of all, and has been the subject of a

[1] See E. C. Willatts, 'The land of Britain, Part 79, Middlesex and the London region' (1937), pp. 192–202.

Government inquiry [1]; secondly, the *Journal* has recently published an article by Dr. W. D. Evans, dealing with some technical aspects of the quarrying industry [2]; and thirdly, the whole matter is at the moment *sub judice*, since a few months ago the Minister of Town and Country Planning appointed Mr. A. H. S. Waters, a well-known civil engineer, to make a special investigation of the whole problem.

The ironstone quarrying industry of Northamptonshire is notorious for several reasons. It is true that a large area of land has been rendered temporarily useless by the dumping of overburden from the deep quarries, though nothing like the area that has been devastated by gravel pits during the same period; but the "hill-and-dale" dumping above ground level is obvious to every traveller through this county of "squires and spires," whereas the gravel pits lie below ground level; and moreover this county contains a rather more vocal and influential population than the market gardeners and suburban dwellers of the Thames valley.

Geology and surface relief within the ironstone fields of the East Midlands are variable, and the restoration problems differ considerably from place to place, and even from quarry to quarry. The nature of the land disturbed by ironstone quarrying is also variable. The ironstone itself, whether Marlstone or Northampton Sand, generally yields good arable soil; so also does the Lincolnshire Limestone which overlies much of the Northampton Sand. Much of the field however and especially that part where the overburden is thickest, has soils developed from Boulder Clay or Estuarine clays and sands, or, in the case of Scunthorpe, from drift sands—all rather poor for farming. Much of the Northamptonshire field formed part of Rockingham Forest, probably almost the poorest agricultural land in the county. There is thus not the same destruction of first-class farmland as in many of the wet gravel-pit areas. The total area of derelict land in the East Midland ironstone fields is less than 3000 acres, of which just under 2000 acres are in Northamptonshire.[3] The problem is not insoluble and experimental work by the Ministry of Agriculture is proceeding. Afforestation may be the most appropriate remedy for the "hill-and-dale" containing limestone blocks. For other areas, levelling, ploughing, and the sowing of suitable crops such as lupins or clover may, with appropriate treatment, produce a new soil in a few years.

The financial aspect is perhaps the most difficult. It is not easy to see how the cost of restoring the old hill-and-dale can be met. The ironstone was only worth 3*s* 5*d* per ton before the war, and it has just been revealed that in opencast coal working, which involves similar excavation problems and in which restoration has been complete, there has been an average loss of 13*s* 8*d* per ton, on produce valued at 22*s* 4*d* per ton, during the first two-and-a-half years' operations.

[1] The Kennet Committee: "Report of the Committee on the restoration of land affected by iron ore working" (H.M.S.O., 1939).

[2] *Geogr. J.* 104 (1944) 102.

[3] S. H. Beaver, 'The land of Britain, Part 58, Northamptonshire' (1943), pp. 372–74. See also "Memorandum dealing with the working of stratified ironstone in the Jurassic system in England," issued by the National Council of Associated Iron Ore Producers (Kettering, July 1944).

Limestone

Limestone is one of the commonest rock types in Britain, especially in England and Wales. It occurs in a great variety of chemical and physical forms, in rocks of many geological ages, and is of such widespread distribution that only two counties in Wales (Cardigan and Montgomery) and two in England (Chester and Cornwall) are absent from the list of producers. Limestone and its products may be used for more different purposes than any other material of the earth's crust, and in consequence Britain is exceedingly fortunate in possessing such vast reserves of many qualities. By tonnage, the three main uses are for lime and cement, as road metal, and as a flux in metal smelting; smaller quantities, usually of special qualities, are used in many chemical industries, in glass-making, and as building and ornamental stone. If the uses of lime are considered, the list expands enormously, and a great variety of manufacturing industries is included, such as soap, glass, leather, rubber, paint, paper, and textiles. Both raw limestone and lime are also used in large quantities for agricultural purposes.

Chalk is a form of limestone, but in official statistics it is differentiated; at the moment, too, chalk is under the control of the Ministry of Works, while other forms of limestone are the responsibility of the Ministry of War Transport. The problems presented by chalk quarrying do not differ materially however from those of other types of limestone quarrying, and the two will be dealt with together, using the word limestone to exclude chalk.

The annual output of limestone more than doubled in the period between the two wars. The county with the greatest output, and with the greatest proportional expansion since 1921, is Derbyshire, which provides roughly one-quarter of the entire output. This is partly due to the large area of the county underlain by high-quality limestone beds, but also to the enormous development of the activities of Imperial Chemical Industries, especially in the Buxton–Doveholes area.

The annual output of chalk in England (there is no chalk in Wales) has shown an even more striking advance in the last two decades, due to the phenomenal growth of the cement industry in south-eastern England; production multiplied three-fold between 1921 and 1939. Despite the widespread outcrop of the chalk formation, some 70% of the output is derived from two counties, Essex and Kent, and in fact a large proportion of this comes from very restricted areas of those two counties, on the banks of the Thames just below London. A single quarry at Swanscombe had an annual output before the war of over a million tons. The only other counties to show a sharp rise in the last twenty years are Bedford and Buckingham, and here again it is the cement industry which is responsible, a single new works near Tring having raised Buckinghamshire from a position of insignificance to one of major importance.

Of all the great geological periods from the early Palaeozoic to the Tertiary, only the Trias is devoid of limestone.[1] In the lower Palaeozoic there are limestones of Ordovician and Silurian ages in Wales and the Welsh border counties, used for roadstone, building and ornamental stone, and lime.

[1] See F. J. North, 'Limestones' (London, 1930), especially Chapters 4–12.

The Devonian limestones of south Devon are used for building and ornamental stone (*e.g.* Torquay "marble"), roadstone and lime, and in south Wales the local "cornstones" have been quarried for roadstone and agricultural use. The Carboniferous Limestone formation provided in 1938 about 46% of the total limestone (including chalk) output of England and Wales. It is of widespread distribution, in the Pennines and north-west England, in north and south Wales, and in the Bristol–Mendips region. In all these areas it is widely used as a road metal, especially in tar-coated form. The iron-smelting industry takes large quantities from Durham and the North Riding, from Furness and Derbyshire, and from south Wales. Lime burning on a large scale is characteristic of Derbyshire, the Craven district of the West Riding, and the Mendips. Cement works based on the limestone exist at Hope and at Clitheroe. Building and ornamental stones are many, but of mainly local use; among the most famous are the Frosterley "marble" of Weardale, the Hopton Wood stone of Derbyshire, and the Halkyn "marble" of Flintshire. Lastly the variety of limestone known as dolomite (containing magnesium carbonate) is quarried as a refractory material, for use in steel furnaces, in eastern south Wales, and in the Oswestry area of Denbighshire.

The Permian or Magnesian Limestone is quarried at frequent intervals along its outcrop from Sunderland to Nottingham. It is only locally important as a dolomite or for lime burning, but has been widely used as a building-stone, especially in Nottinghamshire and south Yorkshire (*e.g.* the Mansfield and Anston stones from which the Houses of Parliament were built); and in one locality, around Coxhoe in Co. Durham, it is quarried on a large scale for the Middlesbrough iron and steel industry.

The Jurassic limestones are many and varied. They are generally softer than the Palaeozoic limestones, and therefore unsuitable for road metal, but they provide many of our most beautiful building-stones, among which Portland Stone and Bath Stone are outstanding and of far more than local significance, while other varieties from the Inferior Oolite of the Cotswolds, the Lincolnshire Limestone of Rutland and Lincolnshire, and the Purbeck of the Isle of Purbeck, are only slightly less important. The Lower Lias in the Midlands and in south Wales yields cement-making material, as does the Lincolnshire Limestone, and also the Great Oolite north of Oxford, while the proximity of the Great Oolite and Lincolnshire Limestones to the iron-smelting industry of Northamptonshire leads to their use as a flux.

The Cretaceous chalk which provided 35% of the total limestone and chalk output in 1938, is a major source of agricultural chalk, of lime, and, above all, of cement. About 70% of the country's cement-making capacity is based upon the chalk. There is one outstanding area, two of lesser importance, and several minor ones. About two-fifths of the cement industry is located on Thames-side, in north Kent (Dartford–Gravesend), and south Essex (Thurrock). There are groups of works on the lower Medway and at the foot of the Chiltern scarp, while smaller establishments exist in the South Downs, on the Humber estuary, and at Ipswich.

The Tertiary limestones (building-stone) of the Isle of Wight which complete the geological succession have long since ceased to have any economic importance.

The following table indicates the relative importance of the various geological formations in limestone and chalk output. It has been compiled from the unpublished Quarries List for 1938, by identifying the geological formation worked at each quarry and adding up the output tonnages, previously impossible owing to the absence of published output figures.

System	*Formation*	*Output (thousand tons)*	*Percentage*
Cretaceous			
Upper	Chalk	10,164	34·6
Lower	Kentish Rag ..	299	1·0
Jurassic			
Upper Oolite ..	Portland, Purbeck, Corallian ..	289	1·0
Lower Oolite ..	Great Oolite, Inferior Oolite ..	1485	5·0
Lias	Lias	1354	4·6
Permian	Magnesian Limestone	1608	5·5
Carboniferous	Carboniferous Limestone ..	13,547	46·2
Devonian	.. .. ..	409	1·4
Silurian } Ordovician }	Wenlock, etc. ..	194	0·7
	Total	29,349	100·0

The relation of limestone and chalk quarrying to agriculture and amenity is naturally variable. All but a very small proportion of our limestone and chalk is obtained from quarries, which may vary from a few feet in depth to the 150 feet or so of the Derbyshire pits. Mining is only resorted to where a particularly valuable stone lies at a considerable depth and has a good roof, as with the Bath Stone of the Box–Corsham district, the Purbeck Stone of the Isle of Purbeck, the Beer Stone (a hard variety of chalk) near Seaton, Devonshire, and a few mines in the Silurian limestones of south Staffordshire.

Both limestone and chalk are widely dug on a small scale for agricultural use; indeed, the small local pit, with or without a lime-kiln, was formerly essential to farming over much of our chalk and limestone lands, for the porous soil needs constant liming to replenish that which is leached away by percolating water. Many of these old farm-pits are now disused, as the mass-produced product is so easily available, but many are still worked intermittently, though they are probably never recorded in the official statistics. Between these small pits and the gigantic quarries at Swanscombe there is every gradation, the rate of devastation and the degree of spoiling caused by the quarries varying within wide limits. Quarries cut into scarps and valley-sides may be more of an eyesore, but may spread less rapidly than quarries excavated in more or less level land.

The damage caused by the quarrying of the older limestones (Carboniferous and earlier) is generally of a different character from that caused by the quarrying of Jurassic limestones and chalk. The older limestones occur mainly in upland areas, where the value of the land for farming is less than it

is in the lowlands, and generally only sheep pastures are destroyed. The scenery of these upland areas however is usually attractive, and while a limited amount of quarrying blends with the landscape and is not objectionable, when whole hills are removed and valleys altered in shape, as in north-western Derbyshire, the working of limestone, and the kilns and occasional cement works which accompany it, become a great nuisance. Doveholes and the Buxton area are probably damaged beyond repair. The industry is such an important one moreover, and so vital to the chemical industries of south Lancashire, that there can be no thought of obstructing it, except to confine the devastation within reasonable limits.

The quarries and cement works at Hope, on the north-eastern edge of the High Peak limestone area, are an interesting example of what the pressure of public opinion can do in preserving the amenities. Cement works in the Carboniferous Limestone must have clay to mix with the pure limestone, and this is obtained at Hope by digging Yoredale shales at the foot of the hill in which the limestone quarry is cut. There is thus a double quarrying activity, combined with cement works, in an area famed for its scenery and used as an open space by the people of Sheffield. The owners of the works have therefore employed a prominent landscape architect to plan a progressive scheme of restoration which will obscure the quarry scars and convert the water-filled shale holes into pleasant artificial lakes.

The Jurassic limestones and chalk generally occur at lower altitudes, seldom much above 600 feet, and while scenery may sometimes be interfered with it is agriculture that suffers most, with a conflict in some areas with housing, especially where the cement industry is involved. The problem however differs from that produced by gravel working, for soils developed on limestone and chalk, though usually arable, are seldom if ever of first quality. Much of the limestone and chalk terrain is typical "sheep-and-barley" farmland, which suffered severely during the agricultural depression between the two wars. Small quarries, as mentioned above, are almost a natural part of the limestone and chalk landscape. Opinions may differ as to the effect of chalk quarries on scarp-faces, *e.g.* the North and South Downs, but chalk quarries only really become a nuisance when they have lime kilns or cement works attached, for here fumes and white dust are added to the rapid eating away of the land by the quarries and the accumulation of dump-heaps of waste from lime burning. When the cement industry intermingles with suburban development, as on Thames-side, the problem is at its worst. In north Kent, for example, the cement companies control some 5500 acres of land, and the expansion of Stone, Greenhithe, Swanscombe, and Northfleet is almost impossible.

Yet there is no denying that Thames-side is the most suitable locality in all England for the cement industry. The chalk lies adjacent to the river bank, river mud or London clay is easily available for mixing with the chalk, private wharves or piers exist for the import of coal and the export of cement, and the vast London market is on the doorstep. The Medway and the Humber offer somewhat similar facilities. The case of the Chiltern works is rather different. Here the marly Lower Chalk is used, which is in itself a natural cement-making material, needing no clay. The chief works are alongside main lines of

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Cement works and quarry in Middle and Upper Chalk, east side of Adur valley, Sussex

Phot. Geol. Survey. Crown Copyright

Quarries in Lower and Middle Chalk, Bletchworth, Surrey

Phot. Geol. Survey. Crown Copyright

Clay pit, Buckley, Flint

Phot. London Brick Co.

Clay pits, Stewartby, Leicestershire

railway where these enter the Chilterns from the north: Sundon (L.M.S. Midland) and Pitstone (L.M.S. London and North Western); the others are on subsidiary lines. The Lower Chalk forms a low platform in front of the main Chiltern scarp, which is made of Middle Chalk, and the main scarp is thus unaffected by the quarrying, though the very fine views from the scarp-top may be slightly impaired by the presence of industrial activity not far from the foot. The economic value of the land for chalk quarrying is far greater than for agriculture; and the works are not mixed up with housing development. They are probably the most satisfactory of all the various groups of cement works.

In the Lower Lias cement works the quarried material consists of bands of limestone separated by thicker beds of clay or shale. Most of the clay is waste, and large heaps thus accumulate. Again the chief works are on main lines of railway, Rugby (L.M.S.) and Harbury (G.W. Birmingham line), with others on secondary lines, some having canal facilities as well. The quarries are mostly deep and do not spread very rapidly. The South Wales works are all on the coast, at Aberthaw, Rhoose, and Penarth.

A special case within the Jurassic area is Portland Isle. Here, in 1938, there were thirty-six active quarries and a number of idle ones, all of which are deep holes with almost vertical sides. The area can only be described as a thorough mess. A unified ownership might have done something to limit the damage, but most people will no doubt be prepared to accept the present condition of Portland Isle as the price to be paid for the beautiful stone frontages of London and many other English towns.

Igneous rocks

Granite, basalt, whinstone, etc., are less widespread than most of the sedimentary rock types. Only about twenty-five counties in England and Wales are regular producers of igneous rock, and only eight or nine of these averaged more than 200,000 tons annually during the inter-war period. These producing counties moreover are almost entirely within Highland Britain, *i.e.* north-west of the Exe–Tees line. The rare occurrences of igneous rock within Lowland Britain are thus exceptionally important for road metal, as in Leicestershire for example, in a region which otherwise lacks suitable material.

The chief English counties, in order of importance, are Leicester, Cornwall, Northumberland, Salop, Devon, and Derby; a large part of the Welsh output comes from Caernarvonshire. Of the whole of Great Britain's output of igneous rocks (separate figures for England and Wales are not available) nearly 90%, in the few years before the war, was used for road making and repairing. About 1% was used for kerbs and paving, and about 1% for building and monumental work. The remainder, in an increasing proportion (4% in 1933, 11% in 1938), was used in the manufacture of concrete and artificial stone.

Not all the occurrences of igneous rocks yield material suitable for road metal and at the same time economically accessible. Very large areas, such as the major part of the Dartmoor granite, the Cheviot granite, the Borrowdale volcanic rocks of the Lake District, and large areas in north and south-west Wales, are almost without active quarries. The volcanic tuffs and lavas are

seldom worked, and it is the basalts, dolerites, and finer-grained varieties of the granitic type which are most in demand for road metal.

Much depends on transport; unlike gravel, which is mainly road-borne for distances up to 30 miles or so, and seldom travels by rail, the igneous rocks commonly make long journeys by rail or sea. The great inland quarries of Leicestershire are all connected to main or branch lines of the L.M.S. or L.N.E. railways, the quarries of Caernarvonshire nearly all have their own small shipping piers. In south-west England, while there are still many small quarries, producing either ornamental granite or roadstone in small quantities, which have to rely on road transport for access to railway or port, the larger quarries of both types are either alongside public railways or have their own private lines, or are adjacent to tide-water. The granites of Dartmoor were quarried extensively during the early part of last century and used in London, but they are less accessible than the west Cornish granites, which are near the G.W. railway and near to small seaports (Newlyn, Porthoustock, Wadebridge, etc.). Thus in 1938 there were only six active quarries in the Dartmoor mass, compared with some thirty-six in the Carnmenellis and Land's End granites.

Where isolated igneous rock outcrops occur, in more accessible regions however, the chances are that they will be vigorously quarried. This is especially the case with the scattered outcrops of the Midlands. Almost every occurrence of igneous rock is picked out by roadstone quarries, as in Leicestershire, in the Nuneaton area, and in the Rowley Hills of the Black Country.

Since igneous rocks are almost invariably more resistant to erosion than the sedimentary rocks which surround them, they tend to stand out as hill masses. In the Midland area referred to above, almost every outcrop is a wooded hill, which renders quarrying comparatively easy, and ensures down-grade haulage from the quarry face. In south-west England the granite masses form low, swelling moorlands, rising above the slaty lowlands. In Wales much of the most spectacular scenery in the north, including the Snowdon and Cader Idris ranges, is due to the volcanic rocks, which stand up sharply from the smoother slate uplands.

It follows then, generally speaking, that the quarrying of igneous rocks does little or no damage to agriculture. In any case, the quarry faces move so slowly, especially if the output is building and monumental stone, and not road metal, that even in a decade there may be very little change. As far as scenery is concerned there is more danger, especially where a large quarry is working a small outcrop, and the original hill formed by the igneous rocks stands a fair chance of completely disappearing, as indeed, Mountsorrel in Leicestershire has already done. Taken all round however igneous rock quarries do much less damage to landscape than limestone quarries.

There are some glaring examples which may be mentioned: the most serious is perhaps the Roman Wall. Here, in the Haltwhistle–Greenhead area, the quarrying of the Whin Sill has done much damage to the Wall, which is built on the ridge formed by the outcrop of the Sill, and a considerable sum of public money has had to be expended in order to prevent the damage from increasing. In the Malvern Hills, again, public subscription has bought out the quarry companies and so preserved certain parts of this fine range. In the

Lleyn, in north-west Wales, a conspicuous granite hill, one of Yr Eifl (commonly known as The Rivals) has been in some danger of having its fine silhouette completely altered by quarrying. In Pembrokeshire the quarrying of some igneous hills for war purposes has endangered ancient monuments. At Penmaenmawr the diorite quarries combine with the Carboniferous Limestone quarries farther east to disfigure a fine piece of coast. In Leicestershire the unsightliness of the huge quarries, with their noisy screening machinery, is increased by the conical waste heaps which accumulate; but the increasing use of waste stone for the manufacture of artificial paving blocks and concrete pipes, may reduce this nuisance.

Brick-clays

There are more than twelve hundred brickworks in England and Wales, and a considerable proportion of these are served by adjacent clay-holes, the remainder depending for the most part on mined colliery shale or old colliery spoilbanks. In the days before railways and mass-production, building had to be done with local materials, and there are very few clay formations up and down the country which have not at some time or other been used for brick-making, and the number of disused clay-pits probably runs into thousands. Many of them are shallow, and have become overgrown; the large ones sometimes remain as ponds.

The brick industry has been very badly documented in the past, and it is only since the Ministry of Works took control in 1940 that it has been possible to get some idea of the exact location and character of all the works. An investigation carried out in the Research Division of the Ministry of Town and Country Planning, with the help of the Secretary to the National Brick Advisory Council, has yielded the following interesting information about the raw materials of the industry.

It appears that just over four hundred works, one-third of the total, are based on shales and clays of Carboniferous age, mostly Coal Measures. All the coalfields, to a greater or less degree, possess brickworks based on the Lower and Middle Coal Measures, either dug from open pits or derived from mines as a by-product of coal-mining; but the chief areas are the Lancashire and Yorkshire fields, Northumberland and Durham, and north Wales. In the Upper Coal Measures, red formations such as the Etruria Marl are of great importance in the Midland coalfields of south and north Staffordshire, Warwickshire, and Denbighshire.

Formations older than the Carboniferous only rarely yield brick-making material. The Old Red Marl is used in eastern South Wales, and Devonian shales and crushed slates in south Devon, and there are one or two isolated works using Ordovician or Silurian shales, in Wales.

Formations younger than the Carboniferous supply the raw material for about two-thirds of the works. In the Triassic, the Keuper Marl is of great importance in the Midlands, and is used occasionally in south-west England. Of the Jurassic clays, far and away the most valuable is the Oxford Clay, especially in the belt between Peterborough and Oxford, and used also farther south-west. Liassic clays are used in the area west of the limestone scarps in Gloucestershire and Somerset. Of the Cretaceous clays, which are

numerous, the most important are the Weald Clay and the Gault, in Kent, Surrey, and Sussex. Tertiary clays are also numerous, and the Reading Beds, London Clay, and Bagshot clays are all used to a great extent in the Thames Basin and in Hampshire. Superficial clays feed a very large number of brickworks. The use of Boulder Clay and allied deposits is widespread, with especial concentration in south Lancashire and north Cheshire, in Northumberland and Durham, and in East Anglia. Clay-with-flints and the associated loams are used on the Chiltern dipslope, and were formerly much more widely used in small works. Brick-earth is important in the Lower Thames area (the home of the London "stock brick"), in East Anglia, and Hampshire. Alluvium and warp are much used along the Humber estuary, in the Vale of York, and on the Somerset Levels.

The following table gives the number of works using each geological formation or group. Some works use more than one type of clay, the combination of Coal Measures and Boulder Clay being common in Lancashire, for example.

Formation	*Number of brickworks*	*Percentage of total works*	*Percentage of total brick-making capacity*
Surface clays (alluvium brick-earth, clay-with-flints)	169	13·9	6·9
Boulder Clay, and other glacial clays	159	13·1	10·1
Tertiary clays (chiefly London Clay and Reading Beds)	146	12·0	4·1
Cretaceous clays (chiefly Weald, Gault, and Wadhurst)	119	9·8	3·8
Jurassic clays (Oxford Clay, also Lias)	78	6·4	35·3
Triassic and Permian (chiefly Keuper Marl)	96	7·9	7·1
Carboniferous shales and clays	381	31·4	27·3
Upper Coal Measures (chiefly Etruria Marl)	66	5·4	4·1
Middle and Lower Coal Measures	301	24·8	22·2
Others	14	1·2	1·0
Mixtures of Carboniferous and glacial or other surface clays	39	3·2	3·3
Lower Palaeozoic	19	1·5	1·8
Other mixtures of surface and "solid" clays	8	0·7	0·2
Total	1214	100·0	100·0

The distribution of brickworks is shown on the map (Fig. 4). It will be noticed that Cornwall and central Wales are almost devoid of brick-making, while there are concentrations of works on some of the coalfields, especially south Lancashire, north and south Staffordshire, and the West Riding. A map showing the distribution of works however gives little idea of the distribution of productive capacity, for some 33% of this is to be found in a few exceptionally large works on the Oxford Clay around Peterborough, Bedford, and Bletchley, and the above table shows that the large number of works in south-eastern England based on Cretaceous and Tertiary clays are mostly of small capacity.

The planning problems arising from clay-pits and brickworks can be

divided into three categories. The single isolated brickworks with clay-hole offers little or no problem. It probably expands very slowly and does not generally grow at the expense of first-class farmland. When however it ceases to function, its ruins and the water-filled hole may be a nuisance. Secondly

Fig. 4

there are the areas where clay-pits and brickworks are concentrated so as to leave little space available in between them for either farming or development. Parts of the Birmingham–Black Country area are like this, a succession of deep holes in the Etruria Marl, separated by derelict land or old dump-heaps. Other similar areas based on Etruria Marl are Walsall Wood, between the Black Country and Cannock Chase, and the Potteries. Buckley (Flintshire) and Ruabon (Denbighshire) together with the area just west of Nuneaton use

Middle Coal Measures and Etruria Marl. Little can be done about areas like this while the industry continues to flourish. If and when it dies, a future generation will have to deal with the deep, water-filled holes and ruined works.

The third category comprises the areas where mass-production of bricks from the Oxford Clay has created enormous holes, accompanied by forests of chimneys. Brick-making began at Fletton in 1880, but mass-production did not begin until 1896, and the series of amalgamations which gave rise to the present great brick companies dates only from 1922; many of the works are the product of the last two decades. The Oxford Clay has an extensive outcrop from the Fenland to Dorset, but so far it is only the eastern part of the belt which has developed the large-scale brick industry, and the works are all alongside or connected to main lines or branch railways. The chief centres are Peterborough, Bedford, and Bletchley, and a considerable proportion of the industry outside the Peterborough area can be seen from the Oxford and Cambridge L.M.S. line. The greatest brickworks in the world, with an output capacity of over 500 million bricks a year, one-sixteenth of the entire British capacity, lies south-west of Bedford, alongside the L.M.S. Bedford–Bletchley line, and with rail connection to the L.M.S. (Midland) main line less than a mile away; the newly created village of Stewartby has been built adjacent to it.

The peculiar suitability of the Oxford Clay for brick-making is due to its "short," *i.e.* but slightly plastic, character, which lends itself readily to machine-pressing, and also to its content (about 5%) of finely divided carbonaceous matter which assists the firing and contributes to the low fuel consumption. There is no other brick clay like it, at any rate in such thick and reasonably homogeneous beds. The clay is mechanically dug, and the overburden and waste material are dumped behind the quarry face in heaps, forming a kind of hill-and-dale. So great a thickness of clay is removed however that the heaps are well below the former ground level. They slowly develop a weedy vegetation and the hollows become waterlogged. Opinions differ as to the possibility of restoring the land to some economic use; if not too waterlogged the heaps might be levelled and made to grow something.

There is one type of brick industry which decreases rather than increases the problem of our dwindling land resources. In the Black Country especially, but also in some of the other coalfields, old shale heaps from coal mining are quarried for brick-making. Generally speaking it is only the oldest spoilbanks which can be used, for the shale in these, if unburnt, is very well weathered, while modern spoilbanks are frequently burnt, and usually contain all kinds of debris besides shale. The spoilbanks are eventually removed, and land otherwise useless is thus levelled and made available for housing or factories. The bricks, too, are of high quality, and can be used for engineering purposes.

Sandstone and Sand

Sandstone consists essentially of quartz grains more or less cemented together, and there is every gradation from the hardest quartzites of pre-Cambrian age, through the massive gritstones of the Carboniferous and the softer sandstones of the Jurassic and Cretaceous to the friable and unconsolidated sands of the Tertiary, and the even looser sand and gravel accumula-

tions of Pleistocene and Recent age, including modern beach and dune sand. In the official statistics there are four categories: sandstone, silica stone (including ganister and silica sand used as a refractory material), moulding and pig-bed sand, and other sand and gravel. Much of our output of sand comes from gravel pits, and it is thus impossible to separate it statistically.

The geographical distribution of sandstones and sands may be briefly analysed. Pre-Cambrian quartzites, used for road metal, occur in Charnwood Forest, the Longmynd and Anglesey. Lower Palaeozoic sandstones, grits, and quartzites, quarried mainly for road metal but also used locally for building-stone, exist in the Malvern and Lickey Hills, in the Nuneaton Ridge, in the Welsh Border district, in north and south Wales, and in the Lake District. The Old Red Sandstone is used for building in south Wales and the Welsh Border counties, while the Devonian of Devon and Cornwall yields occasional building and roadstones. The most important sandstones however are of Carboniferous age. The Lower Carboniferous yields roadstone and local walling and building material in Northumberland (Fell Sandstone) and north-west Yorkshire. The Millstone Grit yields building-stone, flagstone for paving, and massive blocks of stone used for reservoir embankments, engine beds, etc., in the mid-Pennine area of Lancashire and Yorkshire, and in Denbighshire and south Wales. The Coal Measures yield building and paving-stone, refractory material, and grindstones, in most coalfield areas, but especially in Lancashire and Yorkshire. There are sandstones of local importance for building, in the Permian of the Eden valley and Devonshire.

Sandstones of Mesozoic age are mostly softer than those of the Palaeozoic, so that they are seldom used as road metal, but are very important as building-stones, with some important refractory sands also. Triassic sandstones, almost always red in colour, are quarried for building-stone in west Cumberland, in south Lancashire, and in many parts of the Midlands. The same formation contains one of our major sources of moulding sand for metallurgical work, notably in the Mansfield district of Nottinghamshire.

The Jurassic series, which contains so much limestone and clay, has only local sandstones, the most important of which are the Estuarine series of north Yorkshire. Cretaceous sandstones are mostly too soft even for building-stone, apart from local developments such as the Tilgate, Horsham, Bargate, and Pulborough Stones. The formation is rich in sand however and the Lower Greensand yields large quantities for building and glass-making, the latter especially at Leighton Buzzard.

There are no sandstones in the Tertiary, but again sands, *e.g.* Thanet and Bagshot Sands, are important. Of the superficial sands, one of the most important is the Shirdley Hill Sand of south-west Lancashire, which provides much raw material for the glass industry of St. Helens.

Sandstones and sands do not generally yield soils of high agricultural value. The older sandstones and quartzites mostly occur in upland areas where land values are low; the Millstone Grit generally forms moorlands. By contrast some of the Coal Measures sandstones, at lower altitudes, yield arable soils which contrast with the heavy clays developed on the neighbouring shale outcrops. The Triassic sandstones, too, may give quite good quality land, but the Estuarine sandstones of north Yorkshire give rise to country not unlike

the Millstone Grit of the Pennines. The Cretaceous and Tertiary sands commonly yield poor, porous, and badly leached soils, which develop heath and coniferous vegetation, as on the uplands of south-west Surrey and the Bagshot plateau. The Shirdley Hill Sands in south-west Lancashire give very good arable soil, intensively cultivated, but fortunately the deposits are shallow so that restoration is easy.

The quartzite and other road-metal quarries probably extend at a more rapid rate than the flagstone and building-stone quarries, and as with igneous rock quarries they frequently cut into prominent and attractive hills quarrying may affect the landscape. The Lickey Hills, Charnwood Forest, and the Hartshill quarries near Nuneaton are examples. As with igneous rock quarries, huge conical waste heaps are apt to accumulate. The Carboniferous gritstone quarries do not generally interfere with either amenity or with good farming; they have played a notable part in the architecture of the Lancashire and Yorkshire industrial towns, and the streets of most towns in England contain paving-stone from them. It may be a matter for regret that the flagstone industry is dying in the face of competition from artificial stone, but there is little that can be done with the large holes left behind.

The remaining sandstone and sand-pits are seldom concentrated enough in any one area to produce major planning problems. But at Leighton Buzzard, where the valuable bed of high-quality glass-making and refractory sand is of a type that is not common in Britain, and which has been imported in large quantities from Belgium, the spread of the town, especially in a north-easterly direction, is somewhat hampered by the fact that the sand companies own most of the land. The sand is of sufficient value to be regarded as a national resource, and it may be that to avoid sterilizing part of the outcrop, housing may have to give way before quarrying. It is clear that the land cannot be used for both purposes.

Two other quarried minerals only need to be considered; they are both far more localized, and far more valuable per ton than any of those previously considered.

China Clay

China Clay is a mineral of which we possess one of the world's major deposits, of the finest quality. It is very localized, the bulk of it occurring near St. Austell, in Cornwall, with smaller quantities on Bodmin Moor and Dartmoor. China Clay is a decomposition product of the felspar in granite; it is used principally in the manufacture of paper, porcelain, paint, and rubber, but has an ever-increasing range of industrial uses. About two-thirds of the pre-war annual output of 800,000 tons was exported. It is a national resource of importance, and it is essential that it be worked in the most economical manner.

The pure white clay is obtained from open pits which vary greatly in area and depth. Most of them are over 100 feet deep, and the deepest is 370 feet. Pressure hoses are directed on to the pit sides, and the resulting sludge flows along the bottom of the pit to a settling pit where quartz sand and other impurities are separated out. The sand, which is produced at the rate of 5 or 6

tons for every ton of clay, is raised to the surface and dumped in large conical mounds; the clay is pumped up and flows away to settling tanks, which may be some distance from the pit.

In planning two problems arise. The first concerns the huge waste-heaps and derelict clay-pits. It seems impossible to discover an economic use for the sand within or near to the china-clay producing region, at any rate on a scale of some 4 million tons annually. So the dumps will have to go on growing in number and size. The material might of course be transferred to the derelict pits, but this would be a very costly and unproductive undertaking, and moreover very few of the pits can really be considered as worked out, for the clay has generally not been bottomed and as often as not the pits have stopped because the area owned was insufficient to allow the pit to grow wider and deeper and at the same time leave room for the growth of the waste-heap. This introduces the second problem. With the present multiplicity of ownership and royalty areas it is impossible to secure the best working conditions, and in many cases valuable clay is sterilized because the dump-heap cannot be built on land outside the territory owned by the operating company.[1] This of course is most unfortunate when the quality and value of the clay (selling price averaged £1 6*s* 7*d* per ton in 1939) are considered, together with the very limited world resources of such high-quality clay.

Slate

Slate is only found among strata of Lower Palaeozoic and older ages, and its distribution is therefore almost restricted to Wales, the Lake District, and Cornwall. Although within these three areas there are large slate outcrops, the production of roofing slates is confined within fairly narrow limits, for the greater part of the slaty series does not possess the peculiar qualities necessary for the successful splitting of rock-slabs into thin slates. In north Wales, Blaenau Ffestiniog, Bethesda, Nantlle, Llanberis, and Corwen are the principal localities; in central Wales, Corris; in the Lake District, Coniston; in Cornwall, Delabole. The slate is obtained from huge open quarries, or else the best beds are followed underground. The chief characteristic of slate production is the enormous amount of waste; anything up to 95% of the material quarried may be waste, which accumulates in heaps and screes around the excavations. Fortunately the agricultural value of the moorland in which the quarries are usually situated is very low, and as for amenity, the quarries are an imposing landscape feature in themselves; indeed, the north Welsh slate villages probably get more tourists because of the quarries than if there were none. Perhaps the most urgent planning problem is how to keep the industry alive in the face of competition from cheap mass-produced tiles. The slate villages have little other activity to which their attention can be turned.

Geographical summary

The intensity of quarrying, as expressed by the relation between acreage and number of quarries, varies considerably from county to county. Taking the figures for the year 1931, which recorded the greatest number of quarries

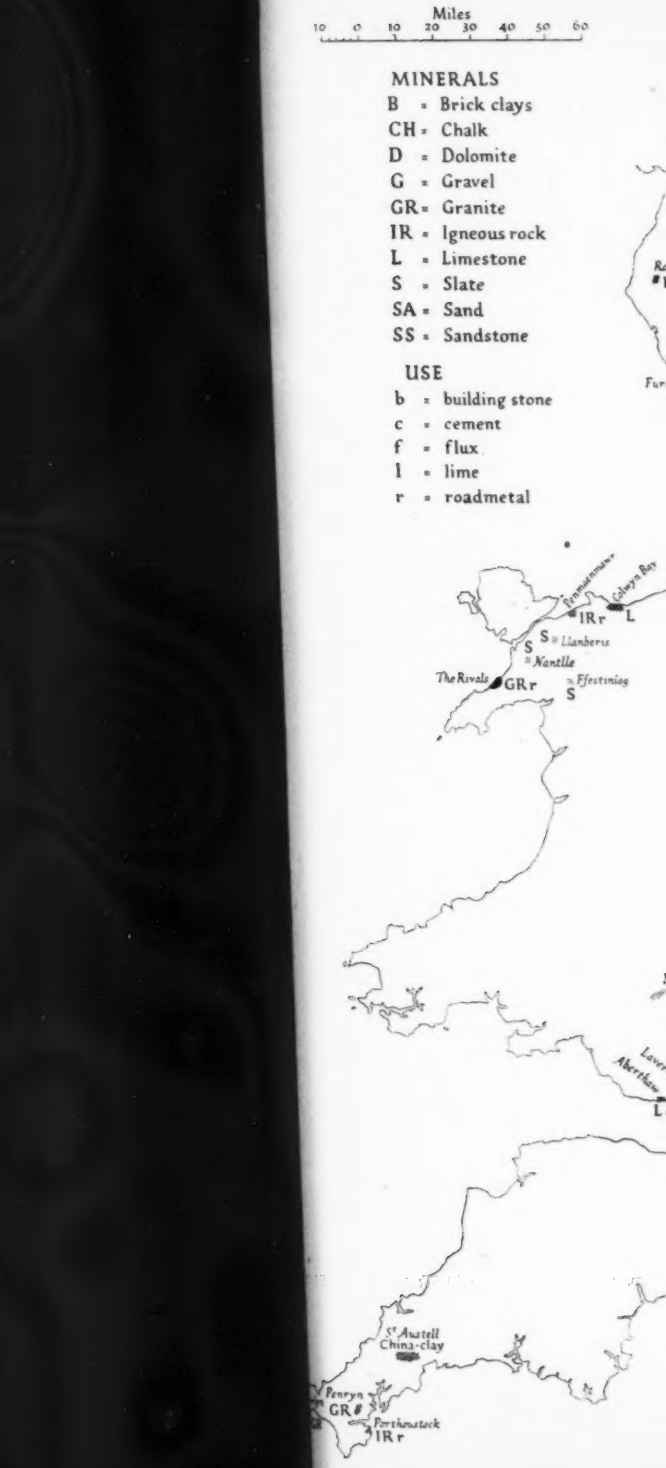
[1] W. R. Jones, "The nationalization of mineral rights in Great Britain" (Institution of Mining and Metallurgy, 1944).

during the last twenty years, the intensity was greatest in Cornwall, with one quarry per 2278 acres of land. The next counties in order were Staffordshire, Derbyshire, Durham, Glamorgan, Lancashire, and Devonshire, the last-named with one quarry to every 4008 acres. At the opposite end of the scale were Lincolnshire, Hampshire, Cambridge (all mainly "chalk" counties), Huntingdonshire, and Hereford. All these had one quarry to more than 20,000 acres. The intensity of quarrying however is not a very good guide to the existence or magnitude of planning problems, for these depend on the nature of the quarries in relation to population, scenery, etc. The folding map (Fig. 5), which indicates the main areas where planning problems exist, to a large extent represents the writer's personal views; it has been compiled from a variety of sources, including the 10-mile Quarries Maps, large-scale topographical maps, personal familiarity with the majority of the areas involved, and an acquaintance with the actual problems which have arisen during the life of the Ministry of Town and Country Planning. A broad viewpoint has been maintained; scrutinizers of the map may well consider that their own particular local problem area has been omitted, but if one included all such local problems the map would be so full as to be indecipherable.

The guiding principle of the map is the phrase "competition with other forms of land use." On this basis three categories of planning problems are distinguished: (i) those of areas in which surface mineral working is in severe competition with other forms of land use, and is raising urgent problems; (ii) those of areas where mineral working is a major factor to be considered in planning; (iii) those of areas where mineral working, though considerable, does not conflict to such a marked degree with other forms of land use. The classification is not to be regarded as rigid, and while there might be general agreement with the areas placed in class (i), others may consider that more areas deserve to be so classified, or that some areas in class (iii) should be in class (ii).

The problems are of local and national significance. When it is a question of preserving the Roman Wall from further desecration, this is clearly a matter of national importance which must override any local interest in quarrying. Similarly it may be regarded as in the national interest that the great population of the metropolitan area should not be deprived of its market gardens by gravel digging; in the national interest too that china clay should not be wasted through an old-fashioned system of land tenure. Most of the problems however are more definitely local in character, though the local authorities may not be able to solve them without guidance and perhaps financial assistance from the centre.

There is little doubt that the two greatest problems are those of gravel in the Thames valley and ironstone in the East Midlands, and in my view the former of these is far more serious than the latter, for reasons already given. In the Lower Thames area chalk quarrying, with its accompanying cement industry, adds to the already grave problem of gravel working. Apart from these major regions, the other class (i) areas are smaller and of a different character. They are areas where considerable agitation has been stirred up against the desecration of the landscape by the quarrying of igneous rocks: the Roman Wall quarries near Haltwhistle (now it is hoped finally prevented


Miles
10 0 10 20 30 40 50 60
MINERALS
B = Brick clays
CH = Chalk
D = Dolomite
G = Gravel
GR = Granite
IR = Igneous rock
L = Limestone
S = Slate
SA = Sand
SS = Sandstone
USE
b = building stone
c = cement
f = flux
l = lime
r = roadmetal
Penmaenmawr
Colwyn Bay
IRr
L
S
Llanberis
Nantlle
The Rivals
GRr
Ffestiniog
S
St Austell
China-clay
Penryn
GR
Perthenastock
IRr

SURFACE WORKING OF MINERALS
IN RELATION TO PLANNING PROBLEMS
Mineral working in severe competition with other forms of land use, and raising urgent problems
Mineral working a major factor in planning
Areas of mineral working with less acute problems
Roman Wall
Whinstone r
Weardale
Lf
Coxhoe
LD
Rowrah
Lf
Lake District
S
Wensleydale
L
Lf
Furness
Horton
Lr
Cracoe
L
Skipton
L
Clitheroe
Lc
Accrington
B
Rossendale
SS
Upholland
SS B
B
Bolton-Leigh
B
St Helens
South-East
Lancs
B
SS
West Riding
Leeds-Holmfirth
Heck
G
CHc
Humber
B
Scunthorpe
Ironstone
L
Conisbrough
G
Doncaster-
Bawtry
Hope
Lc
SA
Worksop
Macclesfield
SS
Buxton
L
Matlock
L
SA
Mansfield
Tattershall
G
Buckley
B
Ruabon
B
Potteries
B
Caldon Low
L
Trent
Valley
G
Breedon
L
GRr
GRr
Ibstock
B
Tamworth
Leicestershire
Walsall Wood
B
B
GRr
Slack Country
B
IRr
B
Nuneaton
Corby
Midlands Ironstone
B
Peterborough
Clee Hills
IRr
Rowley Hills
IRr
Harbury
Lc
Malvern Hills
IRr
Cambridge
CHc
CHc
Ipswich
CHc
Bedford-
Bletchley
B
Leighton Buzzard
SA
Chiltern
Edge
CHc
Colchester
G
Dowlais
Lf
Lea
Valley
G
Thames Estuary
G
CHc
CHc
Medway
South Bucks
and
West
Middlesex
G
Reigate-Redhill
SA
Lc
Lc
Mendips
L
B
Bridgwater
Test Valley
Ramsey
G
Avon Valley
Ringwood
G
Poole
B
Chichester
G
Washington
SA
Lewes
CHc
Lb
Purbeck
Portland
Lb

Fig. 5

from making further inroads into this remarkable national monument), the quarries in the Malvern Hills (partly secured by the National Trust), and the granite quarries in the Lleyn.

At the other extreme, class (iii) areas are mainly those upland areas of hard rocks, limestones, sandstones, or slates, where quarrying is widespread and creates very large holes, but where population is not dense, the agricultural value of the land is low, and the scenery not exceptional. Such are parts of the Mendip Hills (limestone), the Rossendale Moors with their flagstone quarries (many of them extinct), the Pennine dipslope on the western edge of the Yorkshire coalfield (Millstone Grit and Lower Coal Measures gritstones), Weardale, with its very old limestone quarries, the north Wales slate-quarrying areas, the summit of the Clee Hills (basalt quarries), and the moorland wilderness above Dowlais (the great limestone quarries of Trefil).

The remaining areas on the map, in class (ii), are in the majority. Many different types of mineral and problem are involved. Gravel bulks largely, as in the Lea valley (too derelict to be placed in class (i)) and the Trent valley between Derby and Newark (where valuable riverside meadows, which play an essential part in the economy of the valley-side farms, are being replaced by lakes); in the Test and Avon valleys of Hampshire, and around Chichester; also in the dry workings of the Doncaster–Bawtry area, where agricultural values are not high but the pits are very extensive. Chalk generally creates planning problems only when it is associated with cement manufacture, and all the cement-making localities are thus included, some of which almost deserve to be placed in class (i). Such are the lower Medway valley, the Lewes area, the Chiltern edge (Dunstable–Luton), Cambridge and Ipswich, and the Humber Estuary. Limestone working is often destructive of amenity even if there is no cement industry, because of the high quality of the natural scenery. Hope (Derbyshire) is placed in class (ii) and not class (i) because some solution to the problem has been found. Other localities are Skipton, Cracoe, and Clitheroe, all in the fine Craven country, Colwyn Bay on the north Wales coast and the Furness peninsula. The Buxton area has been too much damaged for there to be any hope of restoring the beauty of this fine piece of limestone country, and so it is not placed in class (i). The Lias limestones in Warwickshire, and again on the coast of Glamorgan, appear on the map by reason of the cement industry and the excessive amount of waste rock, already mentioned.

Brick clays create a problem mostly in areas where brickworks are thickly clustered. Apart from the great concentration of Oxford Clay works at Peterborough, Bedford, and Bletchley, there are smaller examples in several parts of south Lancashire, in north and south Staffordshire, in Flint and Denbigh, at Nuneaton, at Bridgwater, and between Bournemouth and Poole.

Igneous rocks create problems in widely separated parts of the country, from the huge quarries at Penmaenmawr to the granite areas of Cornwall and Leicestershire.

The main localities where sand-pits occur in sufficient frequency to cause problems are in the Greensand outcrops of Surrey, Sussex, and Bedfordshire, and the Bunter beds in Nottinghamshire.

Finally there is the china-clay area of St. Austell.

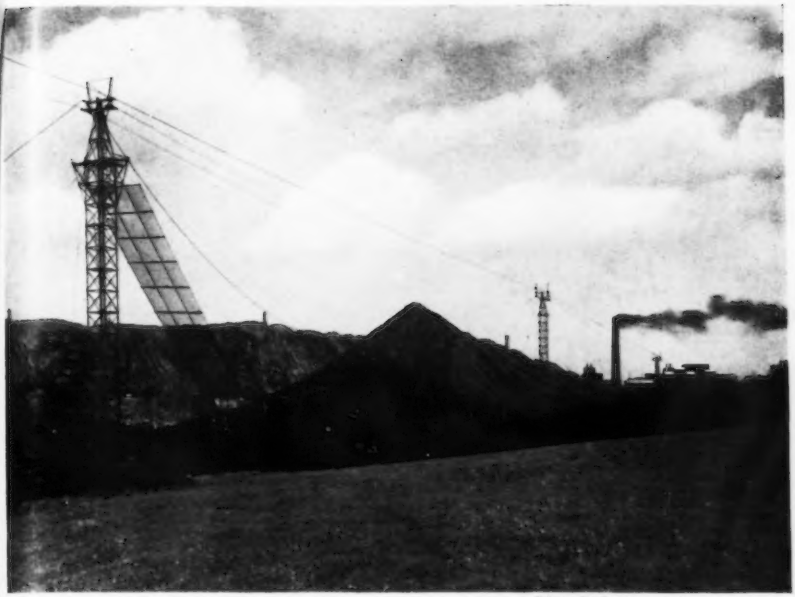
Looking at the map as a whole, one cannot help being struck by the concentration of problem areas in the north-west–south-east belt which has been described as the "axial belt" or "coffin." [1] The lack of continuity in this belt of population and industry, which was emphasized in the discussion referred to, is not present here, for the gap is filled up by the East Midlands ironstone areas and the Oxford Clay brickworks belt. Without reviving this controversy, one is tempted to suggest that the concentration of planning problems in this area is due to the fact that it is within this "axial belt" that development has been most active during the inter-war period, and in consequence the conflict of quarrying with other forms of land use is most apparent here. The map would show a more even distribution of problem areas if mining as well as quarrying were included, for in this case south Wales, the north-east, and Cumberland would be more in evidence.

Coal mining

Almost the whole of our industrial structure is founded upon coal, and it is therefore of the utmost importance to ensure that the mineral is worked economically and without waste. This is a huge problem, outside the scope of this paper, but one aspect of it may be mentioned, namely, the importance of making reasonable estimates of the length of life of our coalfields and of the individual pits within them. Industry in the broad sense may depend upon a coalfield, but mining communities usually depend on individual pits or groups of pits, and one cannot plan for their future without knowing the prospects of the mining of coal from these pits. In the same way, since surface subsidence depends on the precise nature of the mining operations at each pit, only a thorough study by a competent mining engineer can yield information on the liability of the undermined areas to subsidence. Such information may enable the worst areas to be avoided by housing until the subsidence has finished, and suitable precautions to be taken in other areas liable to subsidence. The prevention of subsidence is almost impossible; even underground stowage will not entirely remove the liability. It is possible however to construct light one-storey buildings on land liable to subsidence, and by the use of concrete rafts larger and heavier structures may be built.

Apart from subsidence, the other main problem is the spoilbanks which accumulate at the pitheads. These are of many shapes and sizes and rates of growth, but they all have certain characteristics in common. They consist of shale, stone, and rubbish from the mine, with a certain amount of slack coal and dust from the washery, and much miscellaneous debris. They are liable to take fire, and may burn unchecked for years. The war has had one good result in that these burning spoilbanks had to be extinguished for A.R.P. purposes, and for five years they have been more carefully watched, by the Alkali Inspectors of the Ministry of Health, than ever before. Any process which would either prevent the formation of spoilbanks, *e.g.* by stowing the material underground, or would enable some economic use to be made of the material they contain, would be a most welcome asset to the planning of our active coal-mining areas.

[1] J. N. L. Baker and E. W. Gilbert, "The doctrine of an axial belt of industry in England," *Geogr. J.* 103 (1944) 49–72.



Phot. Geol. Survey. Crown Copyright

Coal tips and aerial railway with safety net, Brodsworth, Yorkshire

Phot. Geol Survey. Crown Copyright

Old quarry in Great Oolite, Milton-under-Wychwood, Oxon

Phot. Geol. Survey. Crown Copyright

Subsidence over Hodbarrow iron mine, Millom, Cumberland

Pot-holed tip heaps, Black Country, near Darlaston

An allied problem concerns the use of the older spoilbanks, lower and more irregular than the modern conical mounds or alpine ridges, and usually covered with a poor vegetation. These products of an earlier period dominate the landscape in the Black Country, and are important features of the older parts of some other coalfields, such as north-eastern South Wales. Sherlock estimated [1] that about 22½ square miles in the Black Country were occupied by old shale mounds: a total accumulation of some 230 million cubic yards of material. A more recent survey for planning purposes has estimated the extent of the slag-heaps and spoilbanks at 6429 acres, or roughly 10 square miles.

The core of the Black Country is bounded by the outcrop of the Thick Coal, and within this area that coal, up to 30 feet thick, has been extracted by shallow mining, and innumerable pot-holes due to subsidence and the collapse of old shafts add to the irregularity of the surface. A weedy vegetation which might almost be called rough grazing covers the heaps. Several brickworks are engaged in quarrying away the spoilbanks, as mentioned above, and in several cases, *e.g.* at Willenhall, attractive parks and playgrounds have been created. There is much room for further developments of this kind,[2] and war-time necessity has shown that large areas of the spoilbanks can be levelled by scrapers and bulldozers and built upon; some hundreds of acres are now in course of treatment in preparation for post-war housing.

Salt

Salt presents another problem in subsidence, but rather more complex than in the case of coal. Most of our salt is now produced by brine pumping. The output of salt from brine in the few years before the war amounted to between 2½ and 3 million tons, compared with under 20,000 tons of mined rock-salt. The pumping of brine, whether or not it follows the mining of rock-salt, produces subsidences, which are much less predictable than those which follow coal mining. The area most affected is the Cheshire Plain, centring upon Northwich.

There are five major saltfields in England: the Cheshire Plain, with centres of production at Northwich, Winsford, Middlewich, Lawton, Plumley, and Heatley; Worcestershire, centred on Droitwich; Lancashire, in the Fylde near Fleetwood; Staffordshire, in the Stafford district, and in the Middlesbrough area of North Riding and Co. Durham (where also, at Billingham, there is mining of anhydrite). In all cases the salt beds are in the Keuper Marl, and there is a reasonable chance of usable deposits occurring elsewhere in the numerous areas underlain by that formation; salt is known in the Bridgwater district of Somerset, for example.

The considerable subsidences in the Northwich district and elsewhere, resulting in the formation of the "flashes" (lakes) and much damage to buildings, were primarily due to the collapse of the old rock-salt mines, but the process was continued with the flooding of the mines and the consequent solution of the pillars and unworked portions of the salt beds, and at the

[1] R. L. Sherlock, 'Man as a geological agent' (London, 1922), pp. 205–6.

[2] See J. W. Sisam and R. O. Whyte, "Establishment of vegetation on coal tips and other spoil mounds," *Nature*, 154 (1944) 506–8.

present time the pumping of brine from these old workings contributes to the progress of subsidence, though catastrophic collapses are less common than formerly. In natural circumstances the salt dissolves very slowly indeed, for any water in contact with it quickly becomes saturated and no further solution ensues. If the brine is pumped up however fresh water takes its place, and gulleys will be etched out of the surface of the salt bed (which is impermeable) by the running water. This gulleying will cause subsidence, but not necessarily in the neighbourhood of the pumping station, for if the water is being drawn from a distance underground, it will be saturated long before it reaches the vicinity of the pumping shaft and so will not dissolve the salt there. For this reason pumping from un-mined salt beds may lead to subsidences far away, and it may be very difficult to decide which pumping station is responsible for which subsidences.

The Cheshire saltfield has an area of some 375 square miles, and of the possible reserve of 15,000 million tons, only one-hundredth part has yet been removed. The possibilities of continued subsidence are considerable; at Northwich the salt beds are about 180 feet thick and only a few hundred feet from the surface. At Winsford the total thickness of salt is 210 feet, all within 500 feet of the surface; at Plumley there are 595 feet of salt within 1100 feet of the surface. Indeed it has been suggested [1] that ultimately, if all the salt were worked out, a large part of the Cheshire Plain would be a lake, beneath sea-level; fortunately however at the present rate of progress this will take thousands of years.

Subsidence in the other saltfields is not so serious, for various reasons; at Billingham for example the salt is overlain by a thickness of between 800 and 1600 feet of strata, including much massive sandstone.

Non-ferrous metals

The mining of lead, zinc, copper, and tin in Britain has been carried on in many parts of Highland Britain for many centuries, and in a large number of cases the ancient workings are so overgrown as to be almost untraceable. More recent activity, during the nineteenth century especially, has left disturbed ground, pot-holed and covered with spoil-heaps, and the ruined remains of pithead gear, engine houses, and smelters—notably in parts of the Pennines (mainly lead mining) and in Cornwall (tin and copper mining). Many of these mines are in more or less remote upland areas, where they cannot be considered to offer any great planning problems. In parts of the Pennines however (including the adjacent Lake District), and especially in Cornwall, where non-ferrous ore-mining has seriously declined during the last half-century, there is no lack of resources, but simply a system of privately-owned mineral rights and taxation which prevent the necessary exploration and large-scale exploitation from taking place. The planning problem is really twofold: is it appropriate and in the national interest to revive the Cornish

[1] R. L. Sherlock, 'Man as a geological agent,' p. 154; see also "Rock-salt and brine" (*Mem. Geol. Surv.*, Mineral Resources, Vol. 18, 1921).

For an excellent account and photographs of subsidence, see A. F. Calvert, 'Salt in Cheshire' (London, 1915), pp. 304–384, 1159–1200.

and other metalliferous ore-mining industries? If, so, by what means may this be accomplished? [1]

The answer to the first question is not just a matter of local interest. Our metalliferous mines provide a training ground for mining engineers who may subsequently go abroad to manage foreign and colonial mines supported by British capital; they provide also a market and an experimental ground for the mining machinery industry, which is an important part of the engineering industry, with a considerable export trade. Clearly a national policy is required. But unless it becomes possible, by the unification of mineral rights presumably under national control, for mining companies to acquire without undue delay and legal expenditure the large territories which are needed before de-watering and deep exploration can be accomplished, and unless there is some relief from the taxation of wasting assets, the best will in the world will not produce the desired stimulation of the mining industry. The artificial boom created by the war-time demand for metals, especially tin and wolfram, will be quickly followed, when this demand ceases, by the inevitable slump from which the industry and all that it means to Camborne, Redruth, and other towns and villages in Cornwall and elsewhere, will never recover. Beside this urgent problem, the question of clearing up the landscape is of secondary importance.

This paper has endeavoured to give a factual background for the study of planning problems arising out of the working of minerals. It is not my function to deal with the administrative and legal problems of control over mineral working. Perhaps I may fittingly end where I began, with a definition of what seems to me to be the aim of planning in respect of mineral working —the formulation of principles, policies, and detailed programmes for the orderly and expeditious extraction of minerals in accordance with both local and national interests and in such a manner as to interfere as little as possible with other forms of land use.

DISCUSSION

Before the paper the PRESIDENT (The Rt. Hon. Sir GEORGE CLERK) said: Fellows will remember that some months ago Mr. J. A. Steers gave us an important paper on the preservation of the coastal scenery of Britain. To-night, Mr. S. H. Beaver, a member of the staff of the London School of Economics, now at the Ministry of Town and Country Planning, and a member of our Council, is to speak to us on an allied and perhaps even more pressing subject: Minerals and Planning. The recent great extension of quarrying and opencast working must clearly lead to much disfigurement of the countryside and to the loss of productive land, unless adequate measures are taken to restore as far as possible the areas to their former condition. We hope to learn from Mr. Beaver the geographical considerations involved in this problem, how far a balance can

[1] "Post-war reconstruction and Cornish metalliferous mining": memorandum from the Cornish Tin Mining Advisory Committee addressed to Lord Woolton, Mr. Hugh Dalton, and Sir William Jowitt (Liskeard, 1944), and "Memorandum to the Minister of Reconstruction on the production of non-ferrous metals and minerals other than coal, in Great Britain" (Institution of Mining and Metallurgy, 1944).

be maintained between conflicting claims, and the possibility of making good or minimizing the inevitable damage.

Mr. S. H. Beaver then read the paper printed above, and a discussion followed.

The PRESIDENT: I think you all share my view that we have had a most interesting and instructive lecture. Time is limited, but I hope that the Minister of Town and Country Planning will spare a moment or two in which to add a few remarks.

The Rt. Hon. W. S. MORRISON (Minister of Town and Country Planning): Ladies and Gentlemen, I am sure I am expressing the opinion of you all when I add my tribute to that which your President has paid to the most admirable, clear, and informative lecture we have listened to from Mr. Beaver. He is one of our most valued advisers. One feature of his lecture which appealed to me was that he showed us how many facets there are to this tremendous problem of mineral working, how the problem varies from mineral to mineral, even from locality to locality within the categories of minerals. The lesson one can draw from this is that proper town and country planning, whatever the many problems with which it is dealing, must be founded precisely upon that far-reaching and meticulous research which is evidently at the back of Mr. Beaver's excellent lecture.

The ideals of the correct recognition of the relation of town and country planning to the mineral problem are, I would say, exactly as Mr. Beaver expressed them in the concluding words of his lecture. Town and country planning is frequently regarded as a somewhat remote activity. There is no real definition of it. The purpose is to achieve the best use of land in the public interest. You will have noticed in Mr. Beaver's lecture that he was not merely concerned, as some think we are in my Ministry, with the amenity aspect of the matter, important though that aspect is to us; he expressed concern as to the industrial consequences which might follow, for example, from a misuse of the china-clay area in Cornwall, and various other aspects of that character, such as tin-mining, if that were allowed to perish. So you will see that we really have in town and country planning to take into account all the factors which determine on which side the balance should tip when it is a question of deciding the proper use of land.

Mr. Beaver is concerned also, as was evident, for the future of the market gardens round London and the devastation being wrought in them by the extension of gravel pits. My colleague and right honourable friend the Minister of Agriculture is present, and he and I have had many anxious conferences on this very aspect of the problem. He and those under him have in collaboration with the Ministry of Town and Country Planning carried out a most useful survey, whereby we are now in possession of the facts that distinguish one part of agricultural land from another, and they at least are very far on in the process of acquiring that essential foundation of factual knowledge.

It is true that the ironstone problem has caused greater agitation than, perhaps, the gravel problem, and I think Mr. Beaver was very near the truth when he explained why there had been so much attention paid to what is only one of the forms of the devastation wrought by the mineral industry. The workings are, for the most part, in agricultural districts and the agricultural population, whether they be squires or farmers, have a profound repugnance to what they consider the murder of good land.

As Mr. Beaver said, we have a committee which is examining this problem of restoration, and we have the services of Major Waters, a most distinguished civil engineer. He has also the distinction of having been awarded the Victoria

Cross, which shows he is fully possessed of those qualities of intrepidity which have made him a suitable man for the task he has undertaken. I believe a good deal of land was left derelict in the past through sheer carelessness, land which would not necessarily need to remain derelict to-day, because of the many advances made in the type of machinery used for excavation. The bulldozer, though it has wrought much damage upon our land during the war, may, on the whole, prove to be a sheep in wolf's clothing, for after the war I believe we shall be able to put it to more beneficent work.

A great deal of the restoration work depends upon the active cooperation of the industries which extract the minerals, and having taken the matter up with a number of ironstone and other mineral workers I find in them a very willing spirit to do what they can, in the first place, to prevent devastation and, if that cannot be prevented, to resort to those practices which restore the landscape to agriculture. I look forward to that spirit of cooperation; indeed, on it I place a great deal of my hope for the future.

Compensation problems connected with mineral workings are in a class by themselves, and very important they are if we are to arrive at a proper solution of this difficulty. In a White Paper issued by the Government on the subject of Control of Land Use you will note that particular reference is made to the problem of compensation in so far as it affects mineral working and the carrying out of it in the right place.

Those are all the remarks which occur to me at the moment. I should like to express my personal appreciation and thanks for a lecture which has been a great pleasure and, I hope, of some benefit to me.

The Rt. Hon. R. S. HUDSON (Minister of Agriculture and Fisheries): Mr. President, Ladies and Gentlemen, you may have read occasionally in the Press during the last four years items which led you to believe that the life of the Minister of Agriculture was not all beer and skittles, but having listened to the lecture you will realize, I hope for the first time, how depressing it often is to be a Minister of Agriculture. It has been my lot to motor in the course of the last four years 120,000 miles over this country. I have seen in person the devastation which Mr. Beaver has described. It seems to me that the only hope for the future lies in an enlightened public opinion. Agriculture hitherto has always been regarded as a Cinderella, and any one who wanted a bit of land for any purpose always thought he was entitled to take it. My experience during the last four years has been that most people resent intensely any moderate or mild suggestion by the Minister responsible that perhaps agriculture ought to have a say.

Recently the London County Council indicated that it wanted to take a large area in the east of London, which was coloured green on one of the earlier maps which Mr. Beaver showed, in order to put up houses. Houses are most important. So are vegetables for the people who live in the towns. It was only a matter of moving a couple of miles so as to get land that was less good for agriculture and which I would not mind giving up. The London County Council asked: Who is the Ministry of Agriculture? They thought we were interfering with their plan, and I am sorry to have to tell you that my colleagues agreed with the London County Council. That is very depressing.

On the other hand, since the Ministry of Town and Country Planning was created and Dr. Dudley Stamp, Mr. Beaver, and various other officials have been seeing what could be done, a great change has taken place. Perhaps I might illustrate that.

On the edge of the Black Country there is an area of really useful agricultural land. The local authorities want to take that for what they call development.

Our officials have been going into it and they have found that there are about 8600 acres of absolutely derelict land, slag heaps, abandoned factories, everything that makes any one of you reluctant to go and live in the Black Country. We found that by the use of modern civil engineering technique 8000 out of those 8600 acres of derelict land could be restored for housing, open spaces, schools, and playgrounds. If you ask is it going to be carried out, my answer is that that can only be done if we get an enlightened public opinion to face up to the possibilities. At no great expense we can clean up the whole of the Black Country from being a national eyesore to making it into a place people would like to go to see. It is up to the people of the country to insist that that be done. Frankly, one of the difficulties is that so many different local authorities are concerned. But that is a matter for my colleagues, Mr. Morrison and Mr. Willink.

As far as I am concerned and as far as the future enjoyment of our land by the people is concerned, I am sure that the research work being done, and which has been so well demonstrated to-night, is absolutely of cardinal importance. We have lost 600,000 acres since the war from so small a country as ours with only 30,000,000 acres of cultivated land in the United Kingdom. Therefore, as far as I am concerned, I should like most heartily to endorse what Mr. Morrison said about the lecture. My only wish is that we could get it repeated in all the cinemas throughout the country, so that people could see what is happening to their land and insist that active steps be taken to stop spoliation.

Dr. E. B. Bailey (Director, Geological Survey): I was unable to arrive in time to hear the beginning of the lecture, but I have been however extremely lucky to have had the opportunity to hear three-quarters of the lecture, because it seems to me that Mr. Beaver has treated the subject with rare knowledge and also with rare sympathy.

There are many aspects of this problem. Speaking as a geologist, naturally I remember that the greatness of our country depends, apart from the human characteristics of its people, upon its mineral wealth. No one would be so foolhardy as to suggest that we should cease developing our minerals, but they have been developed in the past regardless of other interests.

I was delighted to hear Mr. Beaver, when speaking of public interest, refer again and again to the local interest and the national interest. These are often poles apart. Up at the Roman Wall in Northumberland the local interest is the interest of the families congregated in the villages where they have worked for years and years in the stone quarries, and this local interest is to go ahead regardless of the Roman Wall. The national interest, on the other hand, is obviously the preservation of that priceless memorial of our not recent subjugation. There is again and again conflict of local and national interests.

Another point which was clearly brought out during the lecture was that we live in a period of hope because, now that the eyes of the public have been opened, very many of these devastations can be avoided. At the present time there is active exploitation of what is called outcrop coal, and I am glad to say that the Minister of Agriculture has insisted upon the restoration of the land at the earliest possible moment. That has been done partly because we are living in a time when money does not count nearly so much as human costs. That coal was worth while getting, no matter whether it cost more pounds than the underground coal if only it cost less in human labour. In the opening up of the outcrop coal we have met with much the same problems as those previously encountered in ironstone opencast working, and these problems in their new environment have been dealt with excellently.

I have heard recently how certain reservoirs that are to be put upon the best

market-garden land to the west of London are going to be made deeper to go down to the London Clay, and how some of the material to be taken out will be distributed to fill up previous pits. By greater consideration on all sides, as our Ministers have said, and by cooperation, a vast amount can be done to avoid frightful damage to our country.

Dr. DUDLEY STAMP: It is usually my function on these occasions to uphold the point of view of agriculture and of the rural parts of the countryside. That is obviously unnecessary to-night, first, because Mr. Beaver has given agriculture a fair deal throughout his paper and, secondly, in the presence of the Minister of Agriculture and of the Permanent Secretary my function in that regard is clearly unnecessary.

I am led to repeat what I think is a real distinction made in the Scott Report, in which we divide the minerals in this country into two great groups from the land planning point of view. In the first group are those minerals of which in the national interest we shall eventually require to use all that we possibly can. One must put coal, ironstone, and the metallic minerals into that group. Therefore where such minerals occur their excavation must be an overriding consideration in all aspects of planning. The problem in such cases devolves on to the effective restoration of the land. I know that with regard to some minerals I am here treading on delicate ground because it has been suggested that in certain of our great amenity areas the working of minerals should be completely prohibited. I suggest that this is a dangerous doctrine; in the interests of national thrift we require to be able to use all such resources.

In the second group are those minerals which occur in such abundance that we shall never require all that exists. Chalk and clay are examples. The location of quarries and works in such cases can be subject, prior to their actual establishment, to considerations of national planning. In the long run the two main considerations must be the most effective use of the national mineral resources and the restoration of the land after the extraction of the minerals to other uses.

There are two other points arising from the paper which struck me as being of great interest. First, the extreme difficulty of judging public taste. I found myself on certain points in the very rare position of disagreeing with my co-author of our work on the British Isles when he spoke about eyesores. Secretly, I love that break in the otherwise uninteresting line of chalk escarpment which is afforded by the slash of white of the old, or new, chalk quarry. Seen from a distance it seems to me just that point of contrast which adds to beauty. It is a favourite practice of mine, when I have looked at my students and thought they were getting sleepy during a lecture on the British Isles, to confront them with a picture of Cornwall and say: "Look at those curious cones of white sand (the waste from the china clay-pits). Do you like them, or do you not?" About 50 per cent. answer: "Their whiteness catches the sun and affords such a contrast to the rest of the landscape; they really add something." Others say: "Is it not dreadful that we allow such eyesores?"

Mr. Beaver very wisely left alone the whole vexed question of the cost of restoration of land. I would suggest that the narrow point of view of pounds, shillings, and pence is a dangerous one if used in this way: Land costs £20 an acre to buy before working it for the extraction of a mineral; it costs £40 an acre to restore. Therefore you cannot restore it because it is only worth half as much when you have paid for the restoration. It cannot be done. I was given what seems to me an unanswerable answer to such reasoning by a leading cement manufacturer, who said: "Yes, you have forgotten one thing. It costs us £20 an acre. We get perhaps £200,000 worth per acre of minerals out of the

excavation. What is £40 to restore the land suitably for other use and, in so doing, maintain the national asset, our limited amount of land?"

I should like to add my personal appreciation of the way in which Mr. Beaver has covered an extraordinarily wide field with remarkable lucidity and fairness to all points of view.

The PRESIDENT: Well, ladies and gentlemen, the hour is getting late for these days, and so we must conclude. I should have liked to have thanked the two Ministers who addressed us, but their duties took them elsewhere. I am sure I am expressing your feelings when I say that we are not only grateful but also that we have learned something from what they said to us. We have learned, for one thing, the humanity of our Ministers, a quality we do not, perhaps, always realize.

I should also like to add my humble tribute to Mr. Beaver's lecture. It was informative, it was lucid, it was also spiced with a quietly pungent humour which I for one found most refreshing.

I also find myself in agreement with Dr. Stamp in that it seems to me when the bare line of the downs is broken by a flash of white it is an actual improvement of the landscape. I have an open mind about the pyramids in Cornwall. Sometimes I like them; sometimes they fill me with dismay. It is mainly a question of weather. On a typically Cornish summer day they have their attraction. When the weather is lowering and the fog is coming up, the pyramids are, to me, frightful.

But, above all, I echo the wish of the Minister of Agriculture that Mr. Beaver's paper could be reproduced in every cinema in the country. The Minister said that it should be brought home to the public at large. I travelled up to London this morning through Feltham and Ashford. Even from the train one realized the horror of those gravel pits and one was forced to wonder what is going to happen to the stagnant pools of water. I cannot see the remedy. Gravel and cement, as Dr. Stamp has said, have to be used. It is a tragic dilemma out of which I hope science will find a way.

THE ARABIC EDITION OF THE BRITISH COUNCIL MAP: EUROPE AND THE MIDDLE EAST

JOSEPH SCHACHT

Note: The original request, made to the Society in 1940, was for a map in Arabic. This involved compilation in English, but it was hoped that the two versions would be published almost at the same time. The drawings for the map were first seen at a Meeting of the Society in May 1942, and they included a first drawing for an Arabic name-plate, but it was not nearly up to the standard of calligraphy required. Nor were the methods of writing European names in Arabic accepted as the best to be made of a very difficult and controversial matter. The Arabic drawing had to be revised in substance and made again. After many meetings of committees the general principles were agreed, and the Society was fortunate in obtaining the assistance of Dr. Joseph Schacht, who has compiled the decisions made on these principles, but with many necessary exceptions, which are set out in his note which follows. Meanwhile there was a long search for an Arab calligrapher who should work in London under the immediate superintendence of Dr. Schacht, and with the continual assistance of Mr. C. E. Denny. Eventually the services of Mr. Seoudi were obtained in December 1943. And when the drawing for the Arabic name-plate was at last completed and approved in April 1944, there was still the question of making the photogravure plate to fit exactly the other plates of the map, and then of finding the opportunity of printing the map, in some rare interval when the photogravure presses of Messrs. Harrison were not engaged on work of higher priority.

The English edition of the Map of Europe and the Middle East was published in September 1942: the Arabic edition now only in April 1945. The long delay has been disappointing, but in the hard circumstances of the time inevitable. We can hope only that the quality of our ambitious undertaking will be found to satisfy the high standards demanded in such a map.

A. R. H.

THE Arabic edition of the British Council Map No. 1, Europe and the Middle East, made by the Royal Geographical Society, is intended to follow closely the English edition. A few geographical names in Arab countries have been added, and a small number elsewhere omitted, in order to avoid overcrowding. Contour numbering has been omitted, but selected spot-heights are retained. Apart from these details on the black plate the Arabic edition and the English map are identical.

The general principles for the transliteration of geographical names into Arabic were laid down by Professor H. A. R. Gibb as follows: " (1) Foreign names should be spelled in the nearest Arabic equivalent to their pronunciation in their own language; but names for which there are recognized Arabic forms in medieval or modern Arabic should be spelled in these recognized forms. (2) Consonants should be given their classical (or 'Iraqi), not the dialectical (Egyptian) pronunciation. (3) Long or stressed vowels should be represented by Arabic 'weak' consonants, short vowels not represented

unless necessary for purposes of distinction." The following account shows how these principles have been applied in detail by the present writer.

The orthography of geographical names in Arab countries presented no difficulties. In some cases, where there is a modern form different from the old one, the modern spelling was chosen (*e.g. al-Wajh* instead of *al-Wajj*). The official form of the names was followed; therefore one finds *Būr Sa'īd* for Port Said, but *Būrt Sūdān* for Port Sudan.

The established Arabic forms were, of course, adopted for the great majority of geographical names throughout North Africa. Where a modern French (or Italian) name is in general use, it was given either alone, as for Libya, or together with the Arabic name, with the less prevalent form in brackets, as for *Sukaikida* (Philippeville). Berber names were transcribed according to the best form of their somewhat unsettled Arabic orthography that could be ascertained. The Arabic tradition of writing the names of a number of places in the interior of Africa is too weak to be taken into account.

Old-established and well-known Arabic spellings also exist for many geographical names in countries which formed either part of the Arab world at some time, or are situated along its fringes. This holds good particularly for Spain and Portugal, where hardly one name on this map has not its fixed Arabic orthography, and for the islands and coasts of the Mediterranean. In all these cases, the classical Arabic orthography was chosen, and not a transcription from the modern. Where however a new form could be said to have come into regular use in modern Arabic, it was, of course, adopted, either alone or together with the traditional form, the latter in brackets, as in the case of Madrid (*Majrīṭ*).

Essentially the same is the position with regard to those countries that have either used at some time, or are still using, the Arabic alphabet, particularly Turkey, the Balkan countries (formerly parts of the Ottoman Empire), Persia, Afghanistan, India, and Soviet and Chinese Central Asia. Even where a modern national alphabet exists, it was only natural to choose the names established in Arabic literature, and not transcriptions of the modern names. This deference to Arabic tradition implies, of course, neither a reflection on the independence of the Balkan countries nor a criticism of the alphabetical reforms in the Republics of the U.S.S.R. and in Turkey. But wherever a modern name has come into general use in Arabic it was given preference. Therefore the map shows, *e.g.* in the Georgian S.S.R., *Tiflīs* and not Tbilisi for the capital, but *Bāṭūmī* for the place formerly known as Batum.

A difficulty arises from the fact that the Arabic alphabet as used, in the past or at present, for Turkish and Persian, is modified (with variations in detail that are irrelevant here) by additional dots or strokes, in order to distinguish the letters for p, ch [tʃ], zh [ʒ], v and (hard) g, sounds that do not exist in classical Arabic, from the unmodified symbols for b, j [dʒ], z, f, k, and there are further modifications of this kind in Hindustani. The Hindustani modifications had to be neglected in any case, as they would have bewildered the great majority of the prospective users of this map. The Turkish and Persian modified characters are a little better known to some of the educated Arab readers, and the writer personally would have seen no harm in using them not only where they occur in modified forms of the Arabic alphabet, but also

for the transcription of the corresponding sounds in other languages. But even the educated Arab reader, unless phonetically trained, would be unable to pronounce the sounds expressed by the modified characters, notwithstanding all explanations; and the non-Arab users of the map in Persia, Afghanistan, and India will mentally introduce these modifications, wherever they occur. It was therefore considered preferable to neglect the modified characters altogether, and to use the corresponding unmodified Arabic letters. This obviates phonetical explanations, and the names appear in the purely Arabic form in which they have, in fact, always been spelled in Arabic, and sometimes even in Turkish and Persian.

A problem particular to India is the treatment of the aspirated consonants in names of Indian origin. The conventional form of these names in Arabic script, where it exists, is by no means constant; so we find *Laknaw* besides the closer orthography *Lak-hnaw* for Lucknow. The rule adopted in the map is to retain the h wherever practicable. There are also some other fluctuations and inconsistencies in the conventional Arabic spelling of geographical names in India, but the map follows the most prevalent custom.

The difficulty connected with the sounds p, ch, zh, v, g, that has been mentioned above, returns in the transcription of the great mass of non-Arabic geographical names in Europe and Asia (and Africa), for which a conventional Arabic orthography exists only in a restricted number of cases. If modifications of Arabic letters had to be abandoned for countries where a modified Arabic alphabet was, or still is, in use, they had to be ruled out in the case of fresh transcriptions. This also agrees with the views of the Royal Academy of Arabic Language in Cairo. That body, which comprises among its members representatives not only of Egypt but also of other Arab countries, has not yet endorsed any transliterations of individual geographical names, nor published its general rules for transliteration. But it has at least reached a decision on principle, not to use modified Arabic letters. So the best has to be made of the unmodified Arabic characters for the transcription of p, ch, zh, v, and g. In this case, contrary to the treatment of geographical names originally written in a modified Arabic alphabet, there is no reason for choosing the corresponding unmodified letters throughout; but the aim is to arrive, in common with current Arab practice, at the nearest transcription possible with the available characters. The sounds p and v are expressed by b and f, as the Arabs would have to pronounce them in any case. But for ch [tʃ] the map uses t+sh or, if this resulted in a spelling too complicated and bewildering for the Arab eye, simply sh; and for zh [ʒ], the letter *jīm* which is usually pronounced [dʒ], but for which also the alternative pronunciation [ʒ] exists. There remains hard g: this is transcribed either by k or by the letter *ghain* [ɣ], according to the original pronunciation of the word as a whole.

A special case is presented by Chinese geographical names. After a careful consideration, together with Dr. R. Simon, of Chinese and Arabic phonetics, and of the possibilities of the Arabic alphabet, it was decided to express the pairs of Chinese consonants t and t', k and k', p and p', ch and ch', and ts and ts', by t, k, b, j (*jīm*) and t+s respectively.

Vowel signs, which in practice would be omitted in modern Arabic pub-

lications, had to be used as sparingly as possible. Certain consonants peculiar to Arabic and therefore redundant for ordinary transcription purposes (like *ṣ*, *ṭ*, etc.), were used in Turkish very ingeniously for expressing vowel shades that could not be shown by ordinary means. In the map, they are used only exceptionally, as in the transcription for Kuibyshev. But in a name like Magnitogorsk, the first component of which also exists in the Arabic word for magnet, it was natural to make use of the letter *ṭ*.

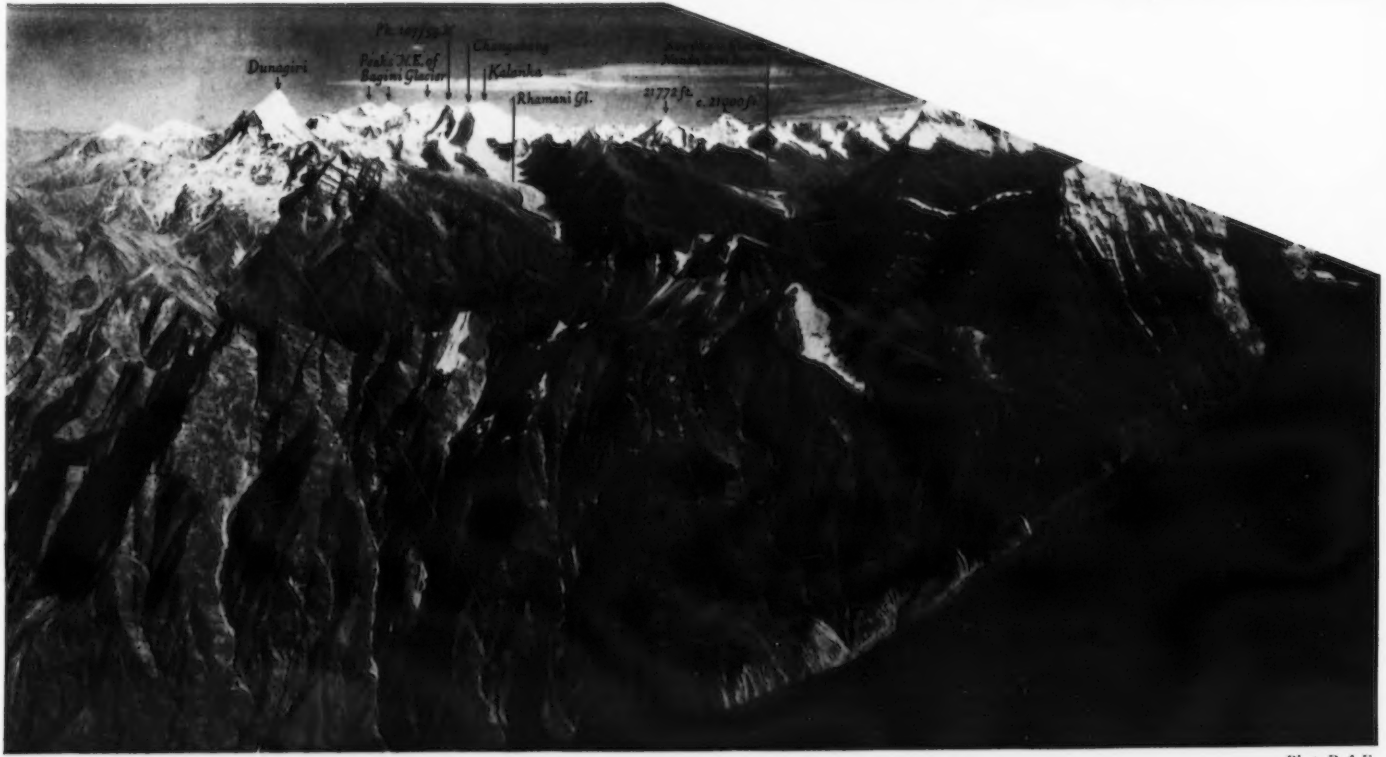
To give a practical transcription which would, as pronounced by the educated Arab reader, come nearest to the pronunciation in the language in question, was considered to be more important than to produce an absolutely consistent system which would inevitably lead to absurdities.

The geographical names in Great Britain, Northern Ireland and Eire, France, Spain, Portugal, and parts of North Africa were originally transcribed by Professor H. A. R. Gibb, who also contributed a number of other important observations. The name-lists for several countries were submitted, wholly or in part, to the following, all of whom made valuable remarks: for Sa'udi Arabia, to H.R.H. Amir Faisal Al Sa'ud; for the Arab countries in general, to Mr. H. StJ. B. Philby; for the Anglo-Egyptian Sudan, to Mr. S. Hillelson; for 'Iraq, to Mr. A. Khalidi, Secretary at the Royal 'Iraq Legation; for Persia, to Professor V. Minorsky, Dr. A. J. Arberry, and Mr. H. D. Graves Law; for Afghanistan, to Professor V. Minorsky; for India, to Dr. A. J. Arberry; for Turkey, to Mr. H. C. Bowen; for China, to Dr. R. Simon. None of them has, of course, any responsibility for the final form in which the names appear on the map.

A FLIGHT IN THE REGION OF NANDA DEVI, 1939

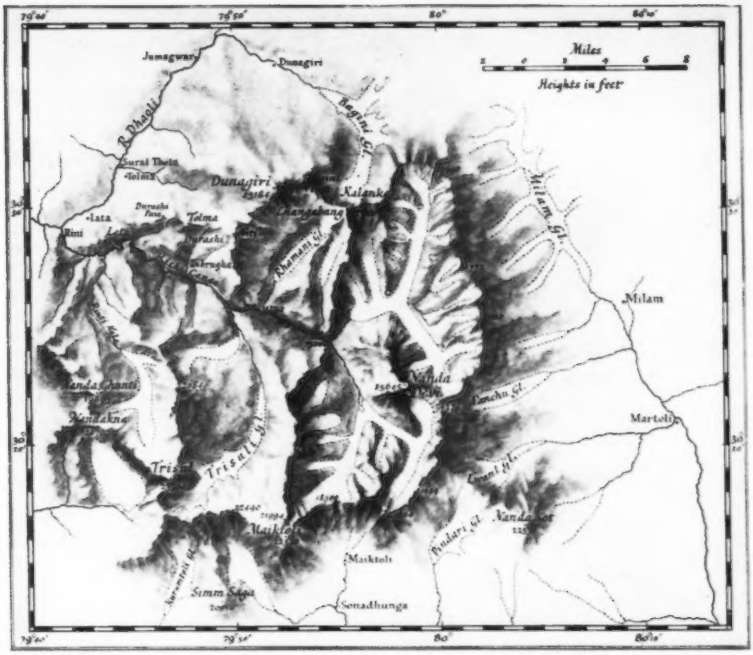
THE Society has been presented by Squadron-Leader A. J. Young with a series of photographs taken on a flight in the region of Nanda Devi. Squadron-Leader T. G. Waymouth, who carried out the flight, and Squadron-Leader Young have described the circumstances. Although this flight was made with the minimum of preparation, it secured some very interesting photographs. In all there are some twenty-nine verticals and one oblique panorama. Accurate records of where the photographs were taken could not be kept, but the panorama has since been identified and is reproduced in this paper with four of the verticals. Mr. Eric Shipton and Dr. N. E. Odell have written notes on the photographs.

On 27 December 1939, a flight was made over the Garhwal Himalaya by Pilot-Officer (now Squadron-Leader) T. G. Waymouth (pilot), Sergeant-Pilot Pinkus (navigator), and Corporal Banister (fitter) in a 2-engine Bristol Blenheim Mk. I. The decision to fly to Nanda Devi was made only just before take-off. Consequently none of the crew were clothed in more than their uniforms and ordinary linen flying overalls; nor were they equipped with oxygen. Despite these severe handicaps they reached a maximum altitude



Phot. R.A.F.

1. Aerial panorama looking north-east from Nanda Ghunti



2. The Nanda Devi Basin, based on a plane-table survey by Eric Shipton and H. W. Tilman, 1936

Phot. Eric Shipton

3. Three peaks at the head of the Bagini Glacier, 1936

(indicated) of between 22,000 and 23,000 feet. At this altitude, though the pilot was fairly comfortable, the navigator was almost overcome by lack of oxygen.

Recently I had the good fortune to obtain the following account of his flight from Squadron-Leader Waymouth.

"In December 1939 I was attached to a squadron stationed at Ambala: the squadron was then equipped with Blenheim I's. December 27 was a cloudless day but rather cold. At that date I had not yet flown twenty hours on Blenheims or twins of any kind and so was anxious to do my second cross-country flight. Being already familiar with the usual cross-countries round the uninteresting Punjab plains, I wanted to fly over new country. After studying the million map, I decided to visit Nanda Devi as I knew it was the highest mountain in British India.

My decision to fly to Nanda Devi was made only shortly before take-off, so we were inadequately dressed for the height to which we had to ascend in midwinter. I was dressed in my blue uniform with nothing over it, but wore a flying helmet because the speaking tubes were handier than shouting. I took with me my folding 4.5 Zeiss Ikonta and also at the last minute had a vertical camera fixed into the Blenheim.

We took off, as far as I remember, just before 1000 hours. I flew on 91° (magnetic) and the distance to Nanda Devi was, I think, 190 miles. I gradually gained height and flew over Dehra Dun at about 15,000 feet. Nanda Devi itself was easily visible above the dust haze at 8000 feet from a good 150 miles. It was then the second high peak from the south, Trisul being the southernmost. We reached the neighbourhood of Trisul in about fifty-five minutes' flying from Ambala. I flew over the snowfields dazzling white in the clear morning sun. The peaks and chasms appeared to be scudding along just underneath me.

The cold was intense and we had no oxygen. It was the cold that kept my senses sharp. While approaching Trisul [1] and at about 19,000 feet I did a steep turn to the right and told the navigator to take a vertical photograph with the Service camera fixed in the belly of the aircraft. The result was an oblique of a range of high mountains (Pl. 1). Trisul was a disappointing mountain to fly over as it was rounded and dwarfed by Nanda Devi's giant peaks. Sergeant Pinkus continued to take photographs of interesting points directly underneath us and I took a few snapshots of the twin peaks and a close-up of the summit of Nanda Devi. The photograph is a little distorted as I took it from about 23,000 feet and so had to tilt the camera. We flew over a very high ridge due east of the peak itself, and the difference in the aspect of the mountain from the north was impressive; whereas the southern face was bright and sunny and almost harmless looking, the northern slope was dark in the shade and not so covered in snow—altogether uninviting. It was round that part that we flew over some huge glaciers and Sergeant Pinkus took some vertical photographs of them. Looking north-west from this height there were range upon range of white mountains for hundreds of miles. To the north, the mountains in the very far distance were free of snow and many of them looked surprisingly rounded. To the east visibility was not so ex-

[1] See Shipton's identification: the pilot was probably over Nanda Ghunti.

cellent as the sun was intensely bright. We were feeling perished with cold and as we had been flying round the top of Nanda Devi, and for close on half an hour over 20,000 feet, I decided not to risk the effects of this great height without oxygen any longer. We flew over a huge razor-like ridge at over 21,000 feet which, I am not absolutely certain of this, seemed to link Trisul and Nanda Devi.

The whole time we were over 20,000 feet I was frankly concerned lest the lack of oxygen might suddenly overcome me at the controls. I purposely concentrated on taking deep breaths, but I cannot say whether this helped or not —but I felt it was helping me. The sky overhead was blue and cloudless and there was a westerly wind blowing.

There was a river gorge going westwards from the Nanda Devi group which seemed the lowest part, so I flew down this with mountains 'brushing my wing-tips.' But it was pleasant coming down to 10,000 feet or so. The river gorge had a couple of rather sharp left-hand turns, otherwise the return flight was uninteresting. We did not fly over Dehra Dun on the way back, but came out over the Ganges at Hardwar. It was good to thaw out. The return to Ambala took about fifty minutes and the whole flight lasted two hours ten minutes.

I went to bed that afternoon with a splitting headache that persisted next day. Corporal Banister obviously enjoyed the flight except for the cold. I asked Sergeant Pinkus how many verticals he had taken and he said 'Six or seven.' Actually he had taken over fifty exposures most of which were very good, and I expect the few he remembered taking were at lower heights.

I rarely mention this flight, as the inevitable question is asked, 'Supposing something had gone wrong when you were up there, were you justified in running the risk?' The answer is an unreserved Yes. I had full confidence in the aeroplane, and in any case the justification lies in that it afforded an interesting and new navigation exercise."

Mr. Eric Shipton's identification of the panorama (Pl. 1), also accepted by Dr. Longstaff, proves that Waymouth was flying over Nanda Ghunti, not Trisul, when the photographs were taken. The two peaks are only some 4 miles apart, and Waymouth was using the 1/M map, which is never easy to relate to the ground, especially over Himalayan country. These maps are used on major cross-country flights when navigation from one point to another is involved rather than for map reading. Also, he was flying at a height which would tend to confuse the identity of even the larger peaks, owing to their comparative insignificance when surrounded with other great mountains.

Judging from Waymouth's account, it seems probable that his route led him from Ambala direct to Nanda Ghunti, thence over the head of South glacier, swinging round to the north, over the col between Nanda Devi and Nanda Devi East and over Shipton's Great North glacier. From here, it seems to me probable that he flew round Nanda Devi, headed up the South glacier, thus completing the circuit of the mountain, and that his "huge razor-like ridge at over 21,000 feet," by which he made his exit from the Sanctuary, was probably somewhere in the neighbourhood of Sunderdhunga Col. From here, Waymouth probably flew down the Pindar river, its sharp

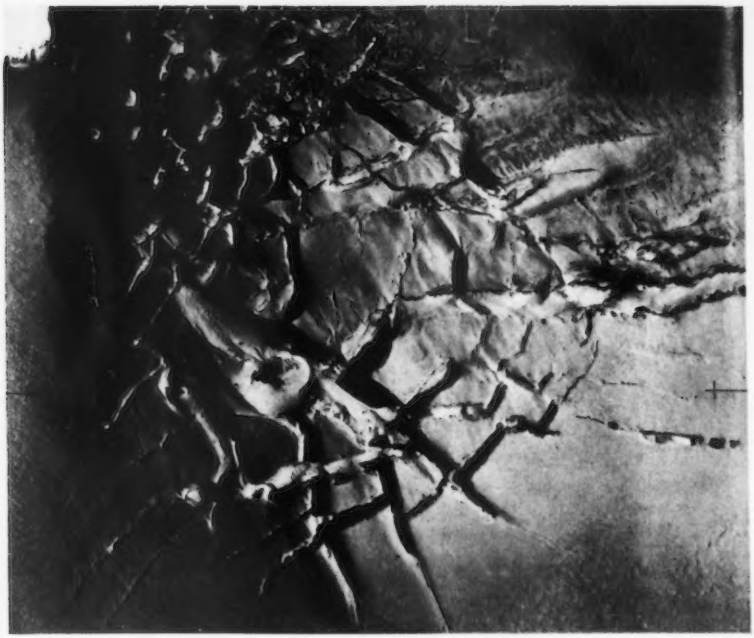
Phot. R.A.F.

4.

Phot. R.A.F.

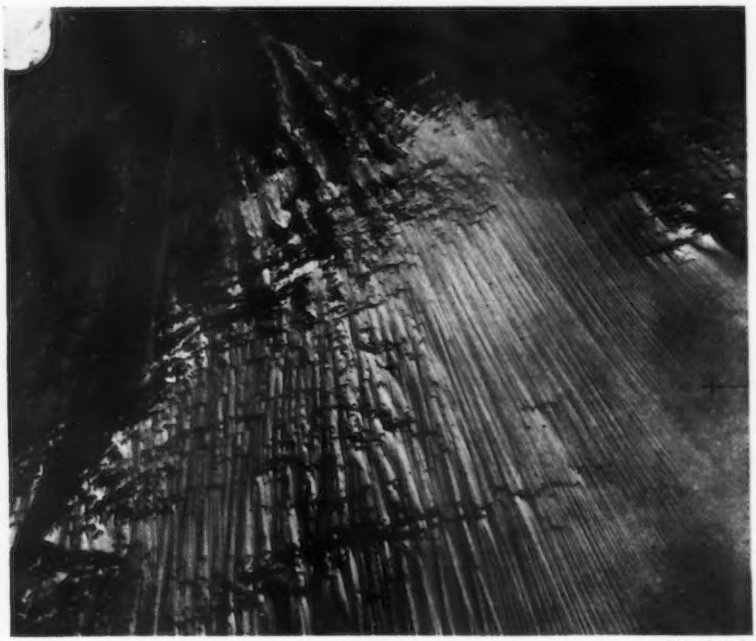
5.

Stages in the falling away of a snowfield, to the west of Nanda Devi, about 21,000 feet



Phot. R.A.F.

6. Falling away of a snowfield, to the west of Nanda Devi, about 21,000 feet



Phot. R.A.F.

7. Snow-fluted slope, possibly on Nanda Ghunti

turns 4 miles above Harmal and at Hat being his "couple of rather sharp left-hand turns." He would then have joined the Alaknanda river at Karnaprayag and followed it down to Hardwar, whence he returned to Ambala.

NOTES ON THE ILLUSTRATIONS

Identifications by Mr. Eric Shipton

Pl. 1. The panorama was taken almost immediately over Nanda Ghunti (G.T.S. peak 75/53 N, 19,893 feet), looking in a north-easterly direction. The first major peak on the left skyline is Dunagiri (see photograph by P. R. Oliver, *Alpine Journal*, 46 (1934), facing p. 144). The next three are peaks lying immediately to the north-east of the Bagini glacier (G.T.S. peaks 21,341 and 23,220 feet are two of these). This can clearly be seen in a photograph taken by me in 1936 from the Bagini pass (Pl. 2). The sharp rock peak to the right is G.T.S. peak 107/53 N to which a height is not given in the Trig. Pamphlet. The next to the right, and slightly in front of the last-named peak, is Changabang, from the foot of which the Rhamani glacier can be seen flowing. Behind that and slightly to the right is Kalanka (Changabang and Kalanka can be seen in my photograph *Geogr. J.* 90 (1937), facing p. 106). Far to the right of that is G.T.S. peak 28/62 B (21,772 feet). Right of that is a peak approximately 21,000 feet, a pyramid-shaped peak which I climbed in 1936, it also lies on the north-eastern rim of the Nanda Devi Basin. The glacier under these peaks is the Northern glacier of the Nanda Devi Basin, to the right of which can be seen rising the North-West ridge of Nanda Devi. The valley in the immediate foreground is the Rinti Nala, the glacier which flows down between Nanda Ghunti and Trisul. Rising above this glacier on the extreme right of the photograph is the Eastern Summit of Nanda Ghunti, G.T.S. peak 75/53 N, lying immediately north of Nandakna. The valley dividing the foreground from the background is of course the Rishi Ganga.

Notes by Dr. N. E. Odell

Pls. 4, 5, *and* 6. I have seen something similar to these photographs in Arctic glaciers. The crevasses, which presumably are all part of the same system, are mostly filled with winter snow, but show secondary tensional cracks. The radial cracks which cut across the crevasses I suggest are due to a sinking or collapse of the glacier surface consequent upon movement of the ice-sheet over a basin in the rock floor. This may have been augmented by rapid drainage of sub-glacial melt-water; but it is not easy to assess the mean gradient of the surface.

Pl. 7. This certainly shows a steep snow-fluted mountain side, possibly on Nanda Ghunti. It is a typical example of Himalayan fluting, which is partly erosional and partly in all probability due to deposition of rime.

REVIEWS

EUROPE

THE PHYSICAL AND THE HUMAN GEOGRAPHY OF THE BRITISH Isles. (In Polish with English résumé.) By ZOFIA HOŁUB-PACEWICZ. *Glasgow: Ksiaznica Polska*, 1944. 8½×5½ *inches; 8+30 pages; folding map*

This pamphlet, which was reprinted from 'Great Britain, land-institutions, culture,' a collection of essays by Polish scholars, attempts to summarize "the most typical geographical phenomena of the British Isles," for Polish students. It contains a layer-coloured map on the scale of 1/3M, and has a short résumé in English. The author gives much attention to the types of coast: recent accumulations, low and high (more than 50 feet) cliffs in areas of old rocks and in the Mesozoic and later rocks, ria coast, rocky and rugged coast with sandy beaches, and fjords are distinguished. This map is fairly successful in distinguishing these, but the scale compels great generalization. The statement in the text that "The 50-foot contour line . . . corresponds to the 50-foot raised beach" is regrettably misleading. Incidentally there are stretches of cliff in Holderness of greater height than 50 feet. There is also an attempt to indicate where erosion has caused the loss of former villages and settlements.

Inland such features as the southern limit of glaciation, and the Jurassic and Chalk scarps are shown. The distinction, on the map, between the last-named and the "Anticline of the Weald" is not clear.

Five grades of cities and towns are shown, some of those belonging to the less than fifty thousand group are indicated but not named. Railways are also marked, but the distinction between important and less important lines is obscure, and the actual courses followed are in one or two cases wrong: for example, the west coast route is rightly marked as important, but it is unusual to leave Paddington and travel via Birmingham to Wigan and Carlisle. Similarly the main route to Bristol does not run via the track between Devizes and Bath.

However the map is an interesting compilation and its blemishes could be easily corrected if a future edition is called for. J. A. S.

MEDITERRANEAN CULTURE. By JOHN L. MYRES. (Frazer Lecture, 1943.) *Cambridge: University Press*, 1943. 7½×5 *inches; 52 pages. 2s*

Five years ago when friends from many countries presented Sir John Myres with a series of papers on the occasion of his seventieth birthday, they turned naturally towards the Mediterranean to which the better part of his life-work has been dedicated. In this lecture Sir John returns once more to this region. The lecture is described as an essay in geographical history. Lightly and provocatively Sir John ranges again from one end of the Mediterranean to the other and, in time, from the Bronze Age or earlier to the present century. His matter is the main patterns which life has taken in this area, the primary economy of the land, the rise of sanctuaries and bazaar cities, the growth of larger states, maritime adventures, piracy, colonization, intrusions from north and south and east. Any one who thinks the subjects sound hackneyed and familiar should turn to the lecture to find out how much that is fresh and arresting, how many new and suggestive analogies, Sir John has to offer: he will be richly rewarded. J. W. C.

ASIA

HOUSEKEEPING AMONG MALAY PEASANTS. By ROSEMARY FIRTH. (London School of Economics: Monogr. on Social Anthropol. No. 7.) *London: Percy Lund, Humphries*, 1943. 9½×7 *inches;* viii+198 *pages; illustrations.* 10*s*

Mrs. Firth's monograph is the result of an investigation into the social and economic conditions of a small fishing village in Kelantan, on the north-east coast of Malaya, in which she collaborated with her husband for eleven months from August 1939 until July 1940. While Dr. Firth was investigating the production and distribution of wealth, the author was engaged in finding out how this wealth was used; so that taking the household as the unit of consumption, this is a study of the housekeeping problems of the society as they affect the whole economy.

The conditions of housekeeping among these Malays who make their living primarily from fishing and other subsidiary occupations are described in detail. Mrs. Firth gives interesting glimpses into the organization of the Malayan families, sometimes composed of two or more separate units, linked by ties of blood or marriage, and emphasizes the predominant position of women in spite of the theoretical disadvantages of Islam. The child's place in the household is also considered, and examples of the daily budgets are included with statistics which clearly show the great importance of rice in the social and ceremonial life of the people. The appendices contain many interesting extracts from the author's notebooks and diary, which together with the diagrams, charts, and some very good photographs help to complete a most comprehensive anthropological survey.

Although the normal life of these hardworking independent Malay fishermen and their households has been interrupted by war and invasion, this searching study will certainly assist in dealing with the problems of restoring this quiet and comfortable pattern of life to them. T. W.

AUSTRALASIA AND PACIFIC

DR. LUDWIG LEICHHARDT'S LETTERS FROM AUSTRALIA, 1842–48. With an appendix. 'Dr. L. Leichhardt as naturalist and explorer,' by Dr. G. NEUMAYER. Translated by L. L. POLITZER. *Melbourne: Pan Publisher*, 1944. 8½×5½ *inches;* 96 *pages; illustrations and sketch-map*

In 1844 Ludwig Leichhardt began his remarkable journey of some 3000 miles from Darling Downs, New South Wales, to Port Essington, and the centenary has revived interest in his achievement and some controversy among Australians. The letters translated from the German in this volume cover the period from his arrival in Sydney in 1842 to the start of his last journey in 1848, on which he proposed to cross the continent from east to west, and from which none of his party returned. The letters show how he prepared to achieve his dominant ambition, to win acknowledgment as a serious traveller, by gaining experience of bush life and by acquainting himself with the natural history and geology of the continent, in continuation of several years' study in Europe. His determination was rewarded by the success of his journey to Port Essington, a success heightened by the outcome of his subsequent efforts. An important letter describes the 1844–45 journey in some detail. He was undoubtedly possessed of a romantic temperament, and given to frequent self-questioning, but at the same time he was never in doubt as to what he wished to achieve.

It is curious that the translator nowhere states definitely the source of the text he has used, though it may be inferred that it is "Dr. Ludwig Leichhardts Briefe an seine Angehörigen" edited by Dr. G. Neumayer, Hamburg, 1881. This collection also contained twenty-nine letters written before he left Europe for Australia, and it is a pity that these could not also have been included, for they throw light upon his qualifications and upon his character in general. On the cover of the book reviewed, but not on the title page, it is stated that it is edited by Mr. Politzer, but all the footnotes are translations of Dr. Neumayer's.

The English translation is straightforward in the main, but a comparison with the German text shows that it is not everywhere satisfactory. There are several misprints and similar errors, *e.g.* "wild horses" for wild hordes, "island" for highland, and "east" for west. The use of "voyage" for journey throughout is difficult to understand, and in one passage is liable to cause confusion; the "picks" referred to occasionally were probably geological hammers. More serious are the omission of short sentences and phrases, without any indication to the reader, and some mistranslations. The letter on the Port Essington journey has suffered rather badly; one passage in particular should be noted. During the journey one of his companions, John Gilbert, was killed by aborigines; Leichhardt states that this occurred "nachdem wir uns niedergelegt hatten"; this is rendered "after I had retired to my tent," which suggests, in conjunction with the change of subject, that Leichhardt was guilty of having been taken unawares; actually he states clearly that he very rarely slept in a tent, though his companions did.

The book has a short preface by Mr. A. H. Chisholm, in which Leichhardt is described as "scatterbrained," "a blunderer," and "capricious." This is not the impression that every reader would gain from the letters, and it seems unfortunate that these charges should be made when space prevents their full examination. He admits however that Leichhardt carried out "one of the longest and most profitable journeys of exploration in all our records." Since Leichhardt has become the subject of controversy, judgment should be suspended until all the relevant documents have been assembled in full and critically assessed.

G. R. C.

ECONOMIC AND HISTORICAL GEOGRAPHY

THE RISE OF FERNANDO CORTES. By HENRY R. WAGNER. (Cortés Society, New Series No. 3.) *Berkeley, California: The Cortés Society*, 1944. 10×7½ *inches;* xxxvi+564 *pages; illustrations*

This important volume includes everything that is known of the life and doings of Cortés up to the final seizure of Mexico City (Tenochtitlán) and subjugation of most of the native folk between Vera Cruz and the Pacific Ocean. I have read all Mr. Wagner's long text with great interest, and wish that this serious worker would undertake to write the necessary sequel, 'The fall of Cortés.'

The story of Cortés is well known, and the author has performed a service in divesting the record of sentimentality, moralizing, and bias. He does not like Cortés, but is fair to him; and in gathering together all evidence of the conquest of Mexico he has produced some new material. All of this is, of course, chiefly from the Spanish side, with some historical material from Spanish-educated men whose blood was at least partly Mexican. But we can only guess what the peoples of Mexico felt at the time of the conquest. It is a tragedy that the whole of the civic architecture of the Mexican peoples, as well as religious temples and their contents, were destroyed by the conquerors, and that most of

the manuscripts of Aztec and Maya shared the same fate. The arts and crafts of these races were so ruined that only a very few specimens of the fine workmanship of the artist in jadeite, mosaic, gold, and feathers remain as evidence of a culture peculiar to the New World. The discovery of the treasures of Monte Alban, a few years ago, were revelations of this artistry.

In the whole tale there is much courage and cruelty; and hardly a trace of happiness or even gaiety; yet the setting is brilliantly coloured, and the drama of such poignancy, that the name of Cortés conjures up one of the great stories of the world.

Proof-reading has not been very good; there are too many errors in spelling and in punctuation. It would have been helpful if a good map of Mexico had been included. L. E. J.

GENERAL

THE PROCEEDINGS OF THE CONFERENCE ON MIDDLE EAST

Agricultural Development. (Agricultural Report No. 6.) *Cairo: Middle East Supply Centre*, 1944. 9½×7 *inches; 220 pages; illustrations*

The four-day Conference which was held at Cairo on 7–10 February 1944 is described as the first to apply, on a regional basis, the lead given at the Hot Springs Conference of 1943. Delegates and visitors represented countries from East Africa in the south to Cyprus and Lebanon in the north, and from Malta in the west to the Punjab in the east, as well as including leading scientists from Britain and the United States. Appropriately the sessions of the first day were devoted to the problems common to nearly all this area: dry farming and irrigation farming. The nine papers afford a valuable conspectus of the present general position and also give some detailed examples drawn from Palestine, Egypt, and Aden. The other four sessions of the Conference were devoted to the problems of reclaiming new land; soil erosion and conservation; research; and regional problems apart from those common to the whole area. An appendix gives an account of the Institute of Rural Life at Beirut.

The fourteen resolutions passed by the Conference serve to emphasize considerations which are, in fact, world-wide: the need for joint action in conservation of land and development of agricultural resources, the application of research, the improvement of standards of rural life, and the continuance into the years of peace of schemes initiated under the stress of war needs.

It is well known that increased prosperity in some of the African grasslands has brought about such a multiplication of numbers of stock as to cause the most serious overstocking and consequent soil erosion. But elsewhere the major problems of soil erosion are due rather to hasty and ill-considered use of modern machinery and methods. It is, consequently, often overlooked that soil erosion is an age-old problem in many lands and native agriculture has been adapted to conserve both soil and moisture. Modern science has much to learn from the old dry-farming methods in the hill lands of south-western Arabia—a combination of terracing and run-off control. But side by side with the demonstration of the importance of sorghum millet in these old agricultural systems is the growing evidence of benefits which may be derived from introductions from climatically homologous areas, in this case Quinoa (*Chenopodium quinoa*) from the High Andes. There is indeed a clear proof of the value of the geographical approach to these problems. L. D. S.

THE MONTHLY RECORD

CAPTAIN CHARLES STURT

On 14 August 1844, Sturt left Adelaide on his expedition to Central Australia. In the course of this he explored the Barrier or Stanley Range, at the southern end of which lies the rich mineral area of Broken Hill. The centenary of the discovery was commemorated at Broken Hill in August 1944, and we have received from the Barrier Field Naturalists' Club a pamphlet containing much information on Sturt and his work. The most substantial contribution is that by the late E. B. Dow, tracing Sturt's route throughout the Expedition of 1844–46, and identifying features named by him. The pamphlet also includes notes on the memorials which now mark the route. Four cairns built by Sturt in the course of his survey are still standing. He appears to have recognized and traced the famous Broken Hill lode, though without realizing the riches it represented.

This expedition was one only of several important contributions by Sturt to the elucidation of the geography of south-eastern Australia. His earlier work largely solved the problem of the westward-flowing rivers of New South Wales. He had traced the Murrumbidgee to its junction with the previously unknown Murray and had descended the latter to Lake Alexandrina (Victoria) and Encounter Bay. Later he had shown that the river discovered by Hume was the upper course of the Murray, and he had forecast correctly that the Darling, the upper course of which he had also discovered, would ultimately be found to reach the Murray.

These explorations of Sturt contributed greatly to the foundation of the Colony of South Australia, and to the establishment of an overland route with New South Wales.

For some years Sturt held public office in South Australia, including for a short period the post of Surveyor-General. In the early 'forties there was much discussion on the character of the interior and on the possibility of establishing communication between the south-east settled areas and the north-west outpost of the continent. In 1844 Sir Thomas Mitchell, Surveyor-General of N.S.W., was preparing an expedition to the upper Darling area, and the connection with the north-west was first accomplished in 1844–45 by Ludwig Leichhardt, who travelled through Queensland and the area south of the Gulf of Carpentaria. This general interest induced Sturt to come forward again with a proposal for another expedition, somewhat boldly offering to explore the whole continent in two years. He, with many of his contemporaries, believed that the centre of the continent was occupied by an inland sea. Though this conclusion proved erroneous, it was derived from observations which were correct in themselves, the fall of the surface west of the Great Dividing Range, topographic features around the course of the Lower Murray, which suggested that the area had once been below sea-level, and the observed direction of the flight of migrating birds. He proposed to begin by crossing the continent from south to north, expecting to encounter the inland sea on the way. The Colonial Office however categorically forbidding him to attempt to reach the north coast, set him a more limited objective. It was surmised from the direction of flow of the Murray system that a dividing range trending north-east to south-west might separate this system from the northern rivers, and Sturt was directed to ascertain if such a range existed.

Sturt was one of the first to challenge the Australian desert. He had not altogether foreseen this, as he had underestimated its extent, and was therefore

not well equipped for the conditions actually encountered. His horse-drawn drays proved unsuited for the sandy surfaces, and the necessity of providing against scurvy, from which Sturt and several others were to suffer, was not realized. Earlier travellers in less arid areas had been able to supplement their diet by gathering indigenous plants. It should be remembered however that he proposed to advance up a watercourse reported to join the Darling at Menindee and to offer a good line of approach to the interior; this proved however to be an insignificant channel, and the character of the journey was thus largely altered. His journey also happened to take place in an exceptionally dry period. So strong was his belief in an inland sea that his equipment included a boat, and he was accompanied by a sailor to manage it.

Despite the unexpected difficulties encountered, Sturt's judgment and determination achieved much. Leaving Adelaide he travelled along the Murray to its junction with the Darling, proceeded up the latter to Menindee, and then struck out north-westwards, discovering the Barrier or Stanley Range in the vicinity of Broken Hill. These low broken mountains, trending from south to north, form the eastern escarpment of the Lake Eyre basin. Owing to the exceptional dryness of the season, water was scarce in the creeks and holes, and each move of the main party was preceded by reconnaissances in search of water. In this fashion, with frequent side journeys to east and west over the featureless plains, the party pushed along the Stanley Range for its extent of 80 miles, continued on to the Grey Range, 40 miles to the northwards, and examined these in the same thorough fashion. Here lack of water threatened not only the further advance, but also the retreat, of the party, and they were obliged to spend six months at a substantial pool at Depot Glen. When the rains came again, Sturt persevered with his plan and made two journeys to the north-west, on the first advancing for 450 miles to 24° 40′ S., until finally defeated by the impossible surface of the Stoney Desert, and on the second finding and examining the great Cooper's Creek, afterwards so prominent in the history of Australian exploration. The return over the same route was a race from water-hole to water-hole. The party reached Adelaide after an absence of seventeen months, having travelled upwards of 3000 miles.

The results of this journey when known in Adelaide caused much disappointment, for it appeared that the expansion of the colony to the northwards was blocked. However when the next phase of exploration opened after the distraction of the gold rushes, pastoralists had opened up better country, particularly to the north-west of Sturt's route, and later explorers had more advanced bases for their journeys into the interior. Prominent among these was John McDoual Stuart, who put to good use his experience gained as a member of Sturt's expedition.

The Society's collection contains two manuscript maps of the expedition's routes, both signed and dated by Sturt. The larger one covers the whole course of the expedition, on the scale of 16 miles to 1 inch. It is signed "Charles Sturt Commanding the Expedition April 17th 1846." It was thus compiled after the return, and is inscribed "Taken from the original drawings by Thomas Munins Hastings." It appears to be the basis of the map published in the *Journal of the R.G.S.*, vol. 17, 1847.

The second map is on the same scale, and shows only the country explored in the earlier part of the expedition. It is signed "Chas. Sturt June 18th 1845." At that date the expedition was still in the field, and was then nearing the end of its enforced stay at Depot Glen. The map is carefully drawn, and the hill shading is neatly done, so that at first sight it appears to be the work of a draughtsman in a drawing office rather than of a surveyor in the field. There

seems to be no reason however to assume an error in the date, or that the map was not executed in the field.

Sturt makes frequent reference to his being engaged in working up his map during the expedition, and pays tribute to the assistance he received from McDoual Stuart, who is described in the list of the party as "draughtsman." At Depot Glen, difficulty in executing this work was experienced through the great heat drying up the colours; an underground chamber was therefore dug, and the work proceeded more smoothly. The map is a creditable production considering the circumstances in which it was drawn, and compares very favourably in execution with the later one. With the exception of a few minor side journeys it appears to include all the tracks of the various parties. The details of these are not always easily reconciled with the accounts, sometimes abbreviated, in Sturt's narrative, and have perhaps been generalized. What appears to be the complete outward and return journey by Browne and Poole to the north of Flood's Creek is shown; the larger manuscript map and the published maps indicate a small portion only.

During June 1845, Sturt was making preparations to send some of his party back to Adelaide, as supplies were running short, and they finally left on July 17. With them they carried despatches and a chart of the expedition's travels to that date, and there seems little doubt that this was the manuscript map of 1845. The position of the Depot Glen is that given in the text of Sturt's narrative; later, as on the larger map, the longitudes were adjusted slightly to the east. No journeys after June 1845 are shown; many conspicuous features are without names, and these are also unnamed in the narrative. The map is thus an interesting relic of an important event in the history of Australian exploration.

G. R. C.

COTTON IN AFGHANISTAN

We have received from Captain O. R. Ginnever the following note on cotton in Afghanistan: In 1935 or 1936 the Afghan Government decided to initiate the growing of cotton, and seed of the American type was obtained from Russia. This was planted in various areas of the country from the Kandahar valley to the plains of Turkistan. The crop produced in the Kandahar area was good, but it was easily excelled by the Turkistan crop where climate and soils resemble those of the Russian cotton region. The seed appears to have been imported by the Russians forty or fifty years ago and has since been acclimatized and developed on the Steppes.

The cotton grown in Afghan Turkistan was of three types: high-grade short staple (7/8 inch long), high-grade medium staple (15/16 inch to 31/32 inch long), and high-grade long staple (1 1/32 inches to 1 1/16 inches long). Four pickings are quite often obtained before the rainy season commences. The cotton of this area is equal to any produced in Russia and compares more than favourably with the American cotton of the same standards. Its character is good, firm, and strong, with a good white "chine" and bloom. Also its colour does not tend towards yellow; as does the American high-grade cotton. The Kandahar crop is not quite as long and strong as the Turkistan crop, but compares favourably with the best types of saw-ginned Punjab cotton from American seed.

The whole scheme is still in its infancy, but the Government are doing their utmost to help its development. In order to encourage farmers to plant cotton the Government gives them the seed free and guarantees to buy the crop at prices fixed annually by the Government for each picking, first to fourth, delivered at the collecting station from which the seed was obtained. Several experimental farms have been started in different parts of Turkistan and

Kandahar, the main one being at Kunduz in Turkistan. During the 1939–40 season, the Kunduz farm grew freshly imported Russian–American seed; local seed which had had three seasons in Afghanistan; seed imported directly from the United States, and from Egypt; and seed which had had several season's growth in Russia. At the end of the season these were all picked, the American styles were saw-ginned, the Egyptian styles roller-ginned, and then both were subjected to 400 atmospheres of pressure and examined. The Egyptian seed from Russia was easily the best; the best American style was from the local-grown seed, and the second best from the imported Russian seed, and the worst from the American imported seed. These experiments showed the necessity for developing strains to suit local conditions.

The cotton industry is a government monopoly controlled by the Banque Mille Afghan through a subsidiary company. Collecting depots and ginneries for cotton have been set up at many points, including Kunduz, Baghlan, Taliqan, Imam Sahib, Mazar-i-Sharif, Daulatabad, Aqcha, and Kalac Zal. Kunduz, Imam Sahib, and Taliqan, have factories with modern hydraulic two-stage baling presses and bale at 400 atmospheres pressure. At present the cotton is collected and ginned at one of the depots, baled into 250-lb. bales in a manually operated press, and brought by camel caravan into either Kunduz, Taliqan, or Imam Sahib, where it is rebaled into high-pressure bales of 400–450 lb. Up to 1940 no statistics had been kept, but I estimate that the 1938–40 crops together were just under 2,000,000 bales of 400 lb. each, and there are still possibilities of expansion.

Cotton-seed oil cake (which is sold locally) and cotton-seed oil are produced at the Kunduz factory. The cotton-seed oil is manufactured into both general purpose soap and a fair quality of toilet soap, a method having been found by an English soap chemist of hardening the soap without importing another oil or fatty acid.

At Pul-i-Khomri the Government in 1939–40 set up a cotton-spinning and manufacturing mill, half the machinery being British and the other half German. It is expected that the mill will produce a large percentage of the light textiles required by the home market.

CHANGES IN THE PROVINCES OF THE DOMINICAN REPUBLIC

In the *Journals* for February and July 1943 changes in the provinces of the Dominican Republic were noted. We have since been informed by the Foreign Office that two new provinces, Altagracia and Trujillo Valdéz, have been created, and one, Monseñor de Merino, suppressed. These recent changes continue the general policy of breaking up the larger districts and forming smaller provinces, of which there are now eighteen and one district. The province of Altagracia, with its capital at La Romana, comprises the communes or districts of La Romana and Higuey, formerly part of the province of Seybo. The province of Trujillo Valdéz, with its capital at Baní, comprises the communes of Baní (including the municipal district of Nizao), formerly part of the province of Trujillo, and of San José de Ocoa, formerly part of Azua. The province of Monseñor de Merino, presumably that referred to as Arzobispo Merino in earlier communications, which has been suppressed, consisted of the communes of Monte Plata, Yamasá, and Bayaguana, which are incorporated in the old province of Trujillo. The provincial divisions of the Republic are given as the District of Santo Domingo (including Ciudad Trujillo), and the provinces of Altagracia, Azua, Bahoruco, Barahona, Benefactor, Duarte, Espaillat, La Vega, Libertador, Monte Cristi, Puerto Plata, Samana, San Pedro de Macoris, San Rafael, Santiago, Seybo, Trujillo, and Trujillo Valdéz.

OBITUARY

LORD MOYNE, D.S.O.

The death of Lord Moyne at the hands of an assassin in Cairo on November 6 was a heavy blow to his country and to this Society. Lord Moyne's services to the nation were many and distinguished. Among the important offices he held were those of Minister of Agriculture, Secretary of State for the Colonies, Chairman of the Royal Commission on the West Indies, and Resident Minister in the Near East. But in this *Journal* it is the loss to our Society that we especially deplore.

Lord Moyne had a first-hand acquaintance, gained through extensive travel, of conditions in many parts of the world, and with his taste for travel he combined wide scientific interests. As a young man he had proposed to devote himself to biological pursuits, but those plans were interrupted by the South African War, in which he served with distinction. Attracted to that continent as a result of these experiences, he carried out several shooting expeditions in Africa. Afterwards the Near East appealed to him, and before 1914 he travelled widely in Asia Minor. Later in his career he took every opportunity that his responsibilities permitted to make extensive voyages for the purpose of scientific collecting on his motor yachts, *Roussalka* and *Rosaura*. The biological, anthropological, ethnological, and archaeological collections which resulted enriched many museums and zoological gardens in this country. The Pacific, and particularly the islands of the south-west, became his principal sphere of investigation, and in all he made six expeditions to these areas. The most noteworthy was that of 1935, when he visited the East Indian archipelago, New Guinea, and the neighbouring islands. From the little known Eilanden and Kampong rivers in south-east Dutch New Guinea he obtained valuable ethnographic material, including specimens of shields and masks previously unrecorded, and of skulls testifying to the presence of Australoid elements in the racial admixture. Later on the voyage, he succeeded in making contact with the Aiome pygmies of the lower Ramu, a group of diverse types of much ethnological interest, whom he examined and described for the first time. In addition to these anthropological and ethnological collections, many rare species of mammals, birds, and reptiles were obtained, some of which were brought home alive, and of these sixteen species were not previously represented in the Zoological Gardens. He described the course and results of this expedition in his book 'Walkabout,' 1936, which combines a pleasant account of his experiences with the scientific results, and is full of valuable observations on the problems arising from the contact of primitive and advanced cultures.

In 1937, on a cruise round the North Atlantic, Lord Moyne obtained a valuable collection of archaic pottery and stone implements from the Bay Islands off the coast of Honduras, and throughout the voyage deep-sea animals were collected for the Natural History Museum. Few of our Fellows have the means to pursue their geographical and scientific interests on this scale, but no one could have used his wealth to better purpose or been more generous in sharing the results of his voyages with our Society and the Zoological Society and kindred scientific associations. Lord Moyne was an outstanding example of one whose life was used to extend our knowledge of the world in which we live.

He joined our Society thirty years ago, and in 1936 he became a Member of Council, and served as Vice-President for four years from 1940 to 1944, an office in which his great experience of affairs and wide interests were highly

valued. On his return from the West Indies he gave to the Society a lucid and penetrating analysis of conditions in the islands in relation to the geographical background, and on several occasions contributed to discussions on papers dealing with his particular interests. In him we lose one who always had the welfare of this Society at heart, who by his work contributed greatly to that welfare, and who we might have hoped would have continued for many years to give us the benefit of his valuable services. He gave his life for his country and no man can wish for a prouder epitaph, but his death is a loss to our Society that cannot be measured. GEORGE R. CLERK.

ARTHUR R. HINKS, C.B.E., F.R.S.

The Society has suffered a most severe loss by the death, on April 18, of Mr. A. R. Hinks, Secretary and Editor of publications for thirty years. Though absent for several months, he had been able until the last week or two to give his attention to the Society's affairs and to the preparation of a new edition of his book on map projections. He had looked forward to his retirement, but at the outbreak of war he readily undertook to continue to serve the Society to the best of his ability, and there is no doubt that this devotion to its interests, so much in keeping with his whole period of service, contributed to his final illness.

Mr. Hinks succeeded Sir John Scott Keltie as Secretary in 1915, so that his years of office coincided with the Society's occupation of its present House, on which, particularly in the planning of the extension opened in 1930, he has left his mark. Of his distinguished scientific attainments, his role as adviser and friend to many travellers, and his work as editor, we hope to publish an adequate account later, but it is fitting that an early, if necessarily incomplete, tribute to his memory should appear in the *Journal* to which he gave so much thought and energy. GEORGE R. CLERK.

FRANCIS EDWARDS

Mr. Francis Edwards, the head of the firm of antiquarian booksellers, died on December 23 in his eighty-fifth year. Mr. Edwards assumed control on the death of his father in 1875, and until his retirement in 1941 was actively engaged in extending the scope of the business. He took a special interest in the records of exploration and travel, and in early cartography. For forty years a Fellow, he frequently helped in acquiring maps and books for the Society, and his wide knowledge was always at the disposal of enquirers. His friendly assistance will be missed by many collectors.

MEETINGS: SESSION 1944-45

The following have been elected Fellows of the Society

On 23 October: R. Abbott, B.A.; Ronald John Andrew; Lieut. Margaret Wildman Arnold, W.A.C.; Captain R. J. B. Bolitho, R.S.; Lieut.-Col. Gail Borden, U.S.A.A.C.; Harold Edmund Box; Smith Bracewell, B.SC., F.G.S.; Flight-Lieut. Leslie G. Cameron; William Robert John Clark-Lewis; Professor Henry Clay; Arthur William Collins; John Reginald Hayden Cook; Count Howard D'Angerville, F.R.S.A.; Miss Sheila De Sa, B.A.; F. Ray H. Green, A.R.S.M., A.I.M.M.; Rev. John Hay; Leslie Alan Hay; Miss Gladys M. Hickman, B.A.; Leonard Jones; Donald M. J. Langdon; Francis W. Lewis; Lieut. Ronald George Lister, R.E.; Captain James Doran McComish; William Richard Mead; Miss Anne B. Miller, B.SC.; Professor Paul Paulovich Muratoff; Captain John Thomas Murphy, R.E.; Sydney Herbert North; Lieut. R. D. Parry, R.E.; Percival Armstrong Saffrey; Christopher Gordon Horsfall Simon; Rai Bahadur Seth Rajkumar Singh, M.A., LL.B.; John Thomas Skinner; Andrew C. Stenhouse; Major Norman Henry Thomas, R.E.; Victor W. H. Towns; Herbert Edgar Trevan-Hawke; Captain Maurice John Turner-Dauncey; Lieut.-Colonel James Watson Twitty, U.S.A.A.C.; Miss Grace Harley Walker; John Williamson; Frank Melson Wingate; George Wesley Wood-Johnson; Captain Brian Worsdall, M.A.; Dr. Harry Yorke, PH.D., M.A.

First Meeting, 6 November 1944. The President in the Chair

Paper: Italian East Africa in 1941. By Lord Rennell of Rodd

Second Meeting, 20 November 1944. The President in the Chair

Elections: Mohamed Ezzat Amed Abou-Hindia, M.A.; Captain Arthur Robert Baxter; Captain M. D. S. Becher; George Herbert Ivan Cornwell, A.M.I.MECH.E.; Sub-Lieut. William Kenneth Paul Deed, R.N.V.R.; George Holland; John Hutchinson, LL.D., F.L.S., V.M.H.; Sub-Lieut. David B. Kimble, R.N.V.R.; Major Charles Guernsey Lakin-Smith; James McGavin, A.M.I.E.E.; Miss Jean Macklin; Dr. Sheffield A. Neave, C.M.G., O.B.E.; Frederick Ernest Samuel Olford; Stephen Frederick Olford; Flight-Lieut. Francis Richard Walter Preston, R.A.F.V.R.; Howard Stephenson; Robert Walter Watts; Norman A. Whinfrey; Professor Sidney William Wooldridge, D.SC.

Paper: Minerals and planning. By Mr. S. H. Beaver

Third Meeting, 27 November 1944. The President in the Chair

Paper: Hadhramaut in time of war. By Mr. and Mrs. Ingrams

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